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Economic analysis of Pakistan's mango exports towards the European Union

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List of Abbreviations

AIDS	Almost Ideal Demand System
AMIS	Agricultural Marketing and Information Services
CEP	Comparative Export Performance
CL	Conditional Logit (Model)
CRS	Constant Return to Scale
DCE	Discrete Choice Experiment
DEA	Data Envelopment Analysis
DMU	Decision Making Unit
DOA	Department of Agriculture
EMA	Export Margin Analysis
EU	European Union
EUROSTAT	European Union's Statistical Office
FAO	Food and Agriculture Organization
FDI	Foreign Direct Investment
FIML	Full Information Maximum Likelihood
GAP	Good Agricultural Practices
GDP	Gross Domestic Product
GLS	Generalized Least Squares
GOP	Government of Pakistan
GSP	Generalized Scheme of Preferences
HWD	Hot Water Dip
HWT	Hot Water Treatment
IIA	Independence of Irrelevant Alternatives
IID	Independently and Identically Distributed
lnRCA	Logarithmic Revealed Comparative Advantage
JGLS	Joint Generalized Least Squares
KPK	Khyber Pakhtunkhwa
LA/AIDS	Linear Approximate AIDS
LIML	Limited Information Maximum Likelihood
ML	Mixed Logit (Model)

OLS	Ordinary Least Squares
PBS	Pakistan Bureau of Statistics
PES	Pakistan Economic Survey
PFVEA	Pakistan Fruit & Vegetable Exporters' Association
PHDEB	Pakistan Horticulture Development and Export Board
RCA	Revealed Comparative Advantage
RSCA	Revealed Symmetric Comparative Advantage
RUM	Random Utility Maximization
SAFTA	South Asian Free Trade Area
SE	Scale Efficiency
SFA	Stochastic Frontier Analysis
SP	Stated Preference
SUR	Seemingly Unrelated Regression
TDAP	Trade Development Authority of Pakistan
TE	Technical Efficiency
VHT	Vapor Hot Treatment
VIF	Variance Inflation Factor
VRS	Variable Return to Scale
WB	World Bank
WTO	World Trade Organization
WTP	Willingness to Pay

1 INTRODUCTION

1.1 Background information

Rapid economic growth is a critical objective of every developing country, with exports being generally considered as a key driver for it. International trade not only acts as a driving force for economic growth but also become a key source of foreign exchange, as noted by MAKHMUTOVA & MUSTAFIN (2017). In this trade, agricultural exports of an agro-based economy like Pakistan play a pivotal role in economic growth as well as in socioeconomic advancement (ATIF et al., 2017). These export activities have a significant positive impact, boosting income for domestic agricultural enterprises and traders, enhancing quality at various stages of agricultural production including cultivation, storage, and transportation, increasing foreign exchange earnings, and driving economic growth (XU et al., 2023). This is especially critical for developing countries with limited national resource bases, to accelerate their development processes.

Over time, the role of agriculture has evolved from merely supplying resources to becoming a sector of paramount importance. Agriculture not only boosts domestic production and exports but also enhances employment opportunities, thereby improving food security in developing countries. The opening of economies through increased participation in international trade has prompted many developing nations to increase their export earnings, thereby enabling them to overcome economic and social challenges. Therefore, the adoption of innovative strategies in agriculture sector is crucial for increasing its export potential (SHABANOV et al., 2021). Technological advancements in fruit production, post-harvest handling, processing and logistics, coupled with higher levels of international investment, have facilitated the export growth.

For developing countries, trading in fruit commodities has become quite challenging amidst their volatile prices in international export market (DIOP & JAFEE, 2005). Fruits, due to their perishable nature, the short lifespan, and specific post-harvest handling and marketing requirements exhibit unique challenges in their trade. These characteristics necessitate scientific and meticulous handling throughout the supply chain. Mango, one of the most widely cultivated tropical fruits in the world, particularly in Asia, requires careful attention in its supply chain management. Countries that have developed this capability over time have outperformed others in mango exports.

Pakistan is recognized as the 27th largest economy globally, a status attributed to its substantial purchasing power, despite being categorized as an underdeveloped country (FARIDI, 2012). With an exception of few years, Pakistan has consistently experienced a trade deficit since its establishment. The country's primary exports consist of textile products, leather, sporting goods, rice, citrus and mango. These exports are primarily directed to a selected group of countries, with approximately 50% going to the United States, the UAE, China, the United Kingdom, Iran, and Germany (GOP, 2020).

Due to the persistent trade deficit, recent trade policies in Pakistan have been primarily centered on expanding exports, improving export competitiveness, and transitioning from a factor-based economy to the one focused on efficiency and innovation. The country is actively engaged in pursuing both bilateral and multilateral trade agreements, including participation in the South Asian Free Trade Area (SAFTA) and the Pak-China Free Trade agreements. Additionally, Pakistan is a member of the World Trade Organization (WTO) and holds GSP^+ status (Generalized System of Preferences) from the USA and the European Union (EU), respectively. Despite being part of these arrangements, Pakistan has not fully capitalized on the benefits, emphasizing the need to enhance its export efficiency.

Pakistan's total cultivated area spans 23.3 million hectares out of a total land area of 79.6 million hectares. The agriculture sector plays a dominant role in Pakistan's economy, accounting for approximately 19 % of the GDP and engaging around 42% of the workforce (AHMAD et al., 2021). It acts as a crucial source of foreign exchange earnings and plays a significant role in stimulating growth in other sectors (GOP, 2018). The total value of Pakistan's agricultural production amounts to USD 66.43 billion. Given Pakistan's reliance on agriculture, the agricultural sector is often referred to as the backbone of the national economy (KHAN et al., 2020).

Horticulture, a sub-sector of agriculture, serves as a cornerstone in fortifying the rural economy. Pakistan, endowed with four seasons and a vast agro-ecological environment, is suitable for the production of a wide variety of temperate, sub-tropical and Mediterranean fruits and vegetables (IKRAM et al., 2020; TALAT et al., 2020). Citrus, mango, and dates emerge as primary fruit crops, making substantial contributions to the national income (GOP, 2020).

Mango, among the various horticultural crops cultivated in Pakistan, due to its unique taste, holds substantial potential for export to other countries (ZAHID et al., 2023). Pakistani mangoes are well-regarded globally for their sweetness, juiciness, nutritional value, and distinctive flavor. However, the ratio of Pakistan's mango export to its production has seen a decline over time due to various reasons (SHAMOON et al., 2020).

Pakistan holds the 6th position globally in mango production, trailing behind India, China, Thailand, Indonesia, and Mexico, with an annual output of 1.7 million metric tons (FAO, 2017). In terms of mango exports, Pakistan ranks at 7th position, following Mexico, India, Thailand, Peru, Brazil, and the Netherlands. The key destinations of Pakistani mangoes include the United Arab Emirates (UAE), Saudi Arabia, the United Kingdom (UK), the Netherlands, Iran, Malaysia, and several other countries in the Middle East and Europe (BADAR, 2015).

Despite with its significant mango production and export position, Pakistan has been unable to harvest its full potential for exports and still faces challenges in the global market. HASSAN & REHMAN (2015) emphasized that Pakistan's share of mango exports in the world market is greater in terms of quantity but lower in terms of value, indicating that the price of Pakistan's mango in the global market is lower compared to other mango supplying countries. Pakistan receives the lowest export price among the top mango-exporting countries (SHAMOON et al., 2020). The country has the lowest total export value (579 USD/ton) when compared to other major mango exporting nations (ZAHID et al., 2023).

A study by GHAFOOR et al., (2010) attributes this to factors such as poor product quality, short shelf life, non-compliance with safety standards, exceeding pesticides residue limits, fruit fly infestation, inadequate packaging, lack of traceability, and high freight charges. Moreover, reliance on traditional mango varieties, inadequate orchard management practices, substandard post-harvest handling, traditional marketing methods, and non-compliance with international standards have constrained the expansion of mango exports from Pakistan.

Importers in developed markets like EU often require traceability of food products along with adherence to standards such as HACCP, Euro GAP, Global GAP, and others. Factors such as controlled temperature, proper packaging, and transportation in reefers play crucial roles in determining the freshness of mangoes and their shelf life. Additionally, local infrastructural development, particularly in roads and storage facilities, can also enhance the marketing efficiency of this delicate fruit.

1.2 Problem statement

The international export market for mangoes is highly competitive, as supplies originate from various geographical sources throughout the year, necessitating the need for improvements in production and marketing systems to meet the evolving requirements at the global level. In this context, it is crucial to analyze the current Pakistan mango trade environment and the challenges that Pakistan mango industry is encountering despite the significant potential and demand of the fruit. To excel in the mango export business, exporters need to have a comprehensive understanding of factors affecting their export efficiency such as product quality, marketing costs, packaging of export consignments, and long-term trade relations with the importers. The mango industry in Pakistan is predominantly operated by the private sector, while government's role is primarily focused on regulating and monitoring various operations within the market and formulating policies & working plans to enhance mango exports from Pakistan.

Recognizing the potential of mango exports, Pakistan government has implemented various measures aimed at improving different aspects of mango production and exports. These efforts have been undertaken by the organizations such as Ministry of Food and Agriculture (MONFA), Ministry of Commerce (MoC), Trade Development Authority of Pakistan (TDAP), Pakistan Horticulture Development & Export Board (PHDEB) (MINISTRY OF COMMERCE, 2012). However, despite these measures, empirical records indicate a decline in Pakistan mango exports, in terms of value. Hence it is important to investigate the mango industry's export performance and identify the major factors affecting it. To evaluate the export performance, along with the socio-economic and business characteristics of exporters, technical efficiency and export margins of the exporting firms are assessed. In order to enhance the export competitiveness of Pakistan mango, special attention has been paid to "economizing the logistics cost" as logistics is the major contributor in export cost structure.

Pakistan remains among the top seven mango exporting countries of the world by exporting around 5% of its total production to more than twenty countries (PHDEB, 2008) but still facing serious challenges in distribution. Currently, exports to markets in close proximity like Gulf countries and Saudi Arabia has almost entirely shifted from air to sea freight (60%) but exports to distant markets like European market are still by air (MALIK et al., 2010).

The increasing cost of air freight is a key factor creating interest to examine sea-freight as an alternative mode of mango transport to EU market. Though sea-freight takes longer time (28-30 days) to deliver Pakistani mango to European market than does air freight but recent developments in container and shipping technology offer maritime service as a viable mode of transportation in future. So, now maritime transport is beginning to compete with air transport in shipping commodities even for perishable food products (COYLE et al., 2015).

Therefore, boosting the competitiveness of Pakistani mangoes in international market through cost-effective and efficient logistics can prove to be valuable in pinpointing the necessity for policy adjustments and delineating economic welfare. Empirical evaluation of export efficiency and the competitiveness of Pakistan's mango export value chain can provide insights into its development. Furthermore, analyzing the exporters’ behavior of transport mode choice and its impact on export competitiveness of Pakistani mango in EU market can offer them better understanding in making optimal decisions of choosing the transport mode.

To understand the extent and potential of mango exports, it is crucial to study comparative advantage. Hence, there is a necessity to analyze the evolving comparative advantage of Pakistan's mango trade over time and its implications for export growth by comparing Pakistan's mango export against major mango exporters. This insight can be helpful in determining whether Pakistan is effectively addressing the challenges of the global mango export market and capitalizing on all the potentials of its highly demanded mango crop.

1.3 Study objectives

The overall objective of the study is to investigate the export performance of Pakistan mango value chain for different target markets and explore the areas of improvement to enhance its competitiveness in high valued market like Europe for policy implications. The specific objectives aimed to achieve in the study are:

- To determine the factors affecting export efficiency of mango exporters for four different markets through a firm-level technical efficiency analysis,
- To identify the high valued export market from exporters’ perspective by conducting a market-specific profitability analysis,
- To examine the transport mode choice behavior of Pakistan mango exporters for EU market and attributes influencing it, and
- To analyze the import demand of mango by European market and assess Pakistan’s competitiveness among other leading mango exporters to this market.

1.4 Rationale of the study

In general, the purpose of the study is to develop an economic understanding about issues and challenges being faced by exporters in Pakistan mango export value chain. Observing the export performances for different target markets and firms' characteristics associated with it, provides a good opportunity to understand the current situation, strengths and weaknesses of different actors involved at various stages in the export value chain. This study provides insights about firm-level export efficiency, factors influencing it, comparative analysis of export business for four different markets, and exporters' behavior of transport mode choice for European market. Furthermore, export competitiveness of Pakistan mango in EU market is also evaluated.

In order to explore the export potential of Pakistan mango value chain and enhance its competitiveness in EU market, a logistics-centric export strategy is elucidated as a way forward. A comprehensive Discrete Choice Experiment (DCE) is conducted to assess the counterfactual effect of different logistics attributes, affecting the mode choice. In the choice experiment, four different transport mode alternatives are provided to exporters in order to evaluate their decision of selecting the optimum freight mode. Lastly, the study also entails the exporters' willingness to pay for improvements in their preferred attributes involved in the mode choice decision.

Among the horticultural exports, since the mango remains the 2nd largest fruit crop after citrus, Pakistan government encourages the private sector to enhance its export, especially to high value markets like Europe with the introduction of trade-friendly policies and institutional support, e.g. WeBOC[1] operations. Meanwhile, it is also important for the mango industry to look for new strategic options to strengthen its export competitiveness in such distant and high return markets. Therefore, in order to reorient the Pakistan mango industry towards a cost-effective export value chain, sea-freighting needs to be investigated as a case study whether it can be a viable option for mango exports to European market. Thus, in order to provide the growing literature, the empirical findings of this study would contribute valuable information for mango sector development's stakeholders and decision makers in designing appropriate policies to look for new windows not only for mango exports but also the future prospect of other agricultural exports and the national economy as well.

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[1] Web-Based One Customs (WeBOC) is an automated system utilized in Pakistan for the efficient clearance of trade consignments. It integrates various stakeholders involved in trade, such as agents, brokers, terminal operators, cargo handlers, and customs officials, in real-time.

1.5 Organization of the thesis

This dissertation is organized into eight chapters. After this introductory chapter, chapter 2 describes the role of agriculture in Pakistan economy, and importance of mango exports in horticulture sector development. It also briefly reviews the mango export supply chain for EU market and major issues & challenges associated to it. Chapter 3 represents the framework of the research design, both types of data used in the study (primary & secondary) and descriptive statistics. After discussing the study area and sampling method in the field survey for primary data collection, descriptive characteristics of exporters, exporting firms, export marketing of Pakistan mango in EU market and its major competitors are presented at the end of the chapter. It is important to highlight here that different empirical approaches have been used for estimation purposes in the study according to the requirement of each research question under consideration.

Chapter 4 provides a comprehensive understanding of the technical efficiency of Pakistan mango exports and its determinants, for three different markets, based on the estimations of data envelopment analysis and truncated regression. Profitability of mango exports in different markets and factors influencing it is assessed with the help of export margin analysis and ridge regression, in chapter 5. Chapter 6 addresses the results of discrete choice experiment for mango exporters' transport mode choice behavior for EU market. In choice modeling, by using the stated preference data, the conditional logit and mixed logit models are employed to estimate determinants of mode choice. Additionally, exporters' willingness to pay estimates for improvement in their preferred attributes is also presented. Chapter 7 examines the mango import demand system of European market, utilizing the time series data in the context of extra-EU[2] and intra-EU[3] imports. It also assesses the export competitiveness among the leading mango exporting countries in EU market by using different export indices. Finally, the last chapter highlights the summary, major findings and conclusion of the study. Based on findings of this research, it also illustrates some policy recommendations for mango sector's stakeholders & policy makers, and indicates the dimensions of future research.

[2] The partner country is the non-EU country of origin of the goods, as defined under union customs legislation (EUROSTAT, 2023).

[3] The partner country is the EU member state, from which the goods are dispatched to another member state for the arrival of the goods according to the trade contract (EUROSTAT, 2023).

2 OVERVIEW OF PAKISTAN AGRICULTURE AND MANGO SECTOR

In this chapter, a general overview of Pakistan's economy and the contribution of major sectors in it, specifically the agricultural and horticulture sector is presented. In addition to it, challenges related to mango production and its export marketing, faced by mango growers and exporters due to unavailability of services and poor management are discussed. Lastly, Pakistan mango exports to the European market and its firm-related, quality control, logistic and policy level issues faced by exporters in exporting to this market have also been discussed.

2.1 Economy of Pakistan

Pakistan lies in the geographical coordinates of 23.35°–37.05° North latitude and 60.50°–77.50° East longitude. It borders with the Hindukush mountains in the North and spans from the Pamirs in the Northeast to the Arabian Sea in the Southwest (GEOGRAPHY OF PAKISTAN, 2023). Being, a significant part of the Indian subcontinent, Pakistan stands at the convergence point of the Middle East and Southeast Asia. It shares its borders with Iran and Afghanistan to the West, China to the North, the disputed region of Jammu and Kashmir to the Northeast, India to the East, and the Arabian Sea to the South (COUNTRY REPORTS, 2023). Pakistan's strategic location offers it a crucial position as a significant trade, energy, and transport corridor to energy-rich Central Asian countries, the Gulf States, and the nations in the East. This distinctive characteristic of Pakistan's strategic positioning opens up a realm of many trade opportunities (FINANCE DIVISION, 2019).

Pakistan encompasses a total area of 796,095 km^2, out of which, the total land encompasses 770,875 km^2 area & 25,220 km^2 of water (FAO, 2023). The country has abundant natural resources with diverse ecological and climatic zones. Predominant among Pakistan's natural resources are its arable land and water reserves (AGRICULTURE STATISTICS, 2016). Figure 2.1 represents the utilization of Pakistan's land; based on cultivated[4], not available for cultivation[5], forest, and other[6] areas.

[4] Areas that are either sown at least during the reference year or the previous year, or sown at least once (Rabi & Kharif) during the reference year.

[5] Areas which are not available for agriculture due to either being totally infertile or being occupied by infrastructure.

[6] Others include cultural waste, current fallow, net area sown, and area sown more than once.

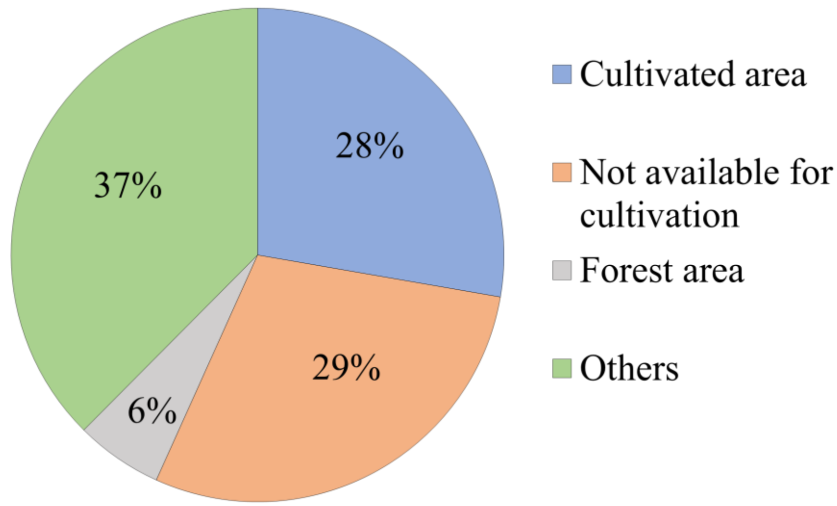

Figure 2.1: Percentage distribution of Pakistan's land utilization

Source: Agriculture department, GOP (2023)

Pakistan, the 5th most populous country (241.49 million) and the 41st largest economy in the world, has maintained an average growth rate of 2.89% over the last five years (FAO, 2023). In 2023, the real GDP estimated was contracted by 0.6%, following a growth of 6.1% in 2022 and 5.8% in 2021 (WORLD BANK, 2023). This decline was influenced by floods causing substantial damage to crops and livestock, coupled with challenges in securing crucial inputs like fertilizers. The industry and service sectors were also affected by supply chain disruptions due to import restrictions, high fuel prices, and money borrowing costs, causing a dampening effect on private investments (WORLD BANK, 2023). Furthermore, Pakistan's economy continues to struggle with uncertainties arising from the global security situation, escalated inflation driven by a surge in food prices, noticeable contractions in large-scale manufacturing, lower-than-expected foreign direct investment (FDI) inflows, and a growing need for increased financing (ECONOMIC SURVEY OF PAKISTAN, 2023).

At present, the real GDP of Pakistan registers a modest growth of 0.29%. The economy grappled with significant challenges, including macroeconomic imbalances, supply shocks, and the effects of a global economic slowdown, all of which subdued economic growth (ECONOMIC SURVEY OF PAKISTAN, 2023). The GDP at current market prices in 2023 amounts to USD[7] 30,327 million, indicating a

[7] Average exchange rate: 1 USD = 279.15 PKR (2023) and 204.56 PKR (2022)

substantial 27.1% increase compared to the 2022 value of USD 13,628.5 million (Economic Survey of Pakistan, 2023). Pakistan's imports and exports have also displayed fluctuating trends (Figure 2.2). In 2021, imports surged to 18.0% while exports stood at 9.1%. However, by 2022, imports rose further to 22.5% while there was a modest increase of 10.5% in exports. Notably, in 2023, there was a slight decline in imports to 17.7% while exports maintained a consistent growth trend, reaching at 10.1% (Pbs, 2023).

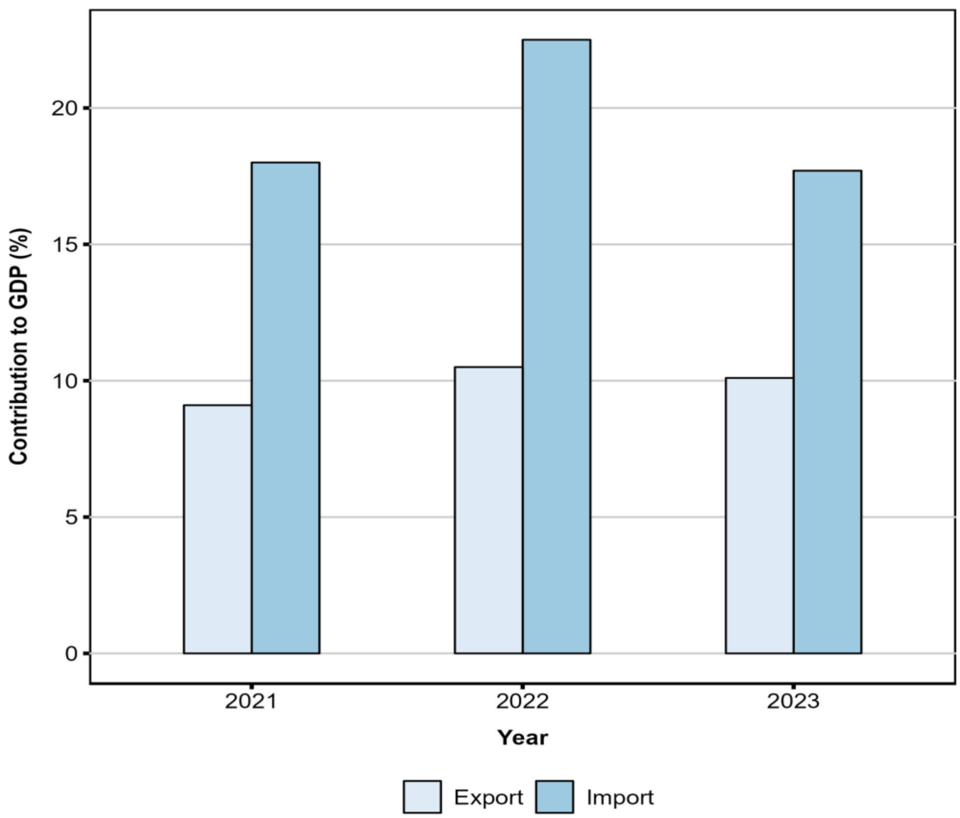

Figure 2.2: Pakistan's exports and imports as % of its GDP

Source: Pakistan Bureau of Statistics (PBS), 2023

The major sectors of Pakistan economy are agriculture[8], industry[9], and services[10] contributing 19%, 20%, and 61% on average, respectively, to the GDP (Finance

[8] Agricultural sector includes trade of major and minor crops, livestock, fisheries and forestry.

[9] Industrial sector is involved in trading of mining & quarrying, manufacturing at small and large scale, construction, and electricity & gas distribution.

[10] Services sector encompasses transport, storage, communication, wholesale & retail trading, finance & insurance, public administration, defense, and S & P services division.

DIVISION, 2019). As per PBS (2023), the services sector is the largest contributor to Pakistan's economy, comprising 58.6%, followed by agriculture at 22.9% and industry at 18.5%. Within the services sector, wholesale and retail hold the largest share of 18% of GDP. In agriculture, livestock dominates with a 62% share and an overall contribution of 14% to GDP. Manufacturing holds a 65% share of the industry and contributes around 13% to the overall GDP. The per capita GDP stands at USD 1,568 with 39.4% of the population living below the poverty line (3.6 USD /day) (FAO, 2023).

Similarly, from the same report of FAO (2023), it was reported that Pakistan had historically faced a trade deficit issue in 2023, reaching USD 27.5 billion (0.7% of the GDP). Pakistan's exports amounted to USD 27.7 billion, capturing 0.13% of global exports, while imports totaled USD 55 billion, making Pakistan globally the 47th largest importer. Textile exports account for 60% of total exports, and Pakistan ranks as the 4th largest rice exporter globally, renowned for its Basmati rice. Imports consist of 75% capital goods & raw materials and 25% consumer goods. Energy imports make up a significant 35% of total imports, with indigenous oil production meeting 30% of domestic energy demand. Food imports have risen to USD 9 billion, half of which is accounted for by edible oil.

Pakistan boasts an estimated livestock population of 225 million, generating a value addition of USD 19.7 billion in 2023 (FAO, 2023). As the 5th largest milk producer, Pakistan yields a gross annual production of 67 million tons. The substantial livestock population also facilitates USD 950 million in leather exports, positioning Pakistan as the 4th largest leather apparel exporter (FAO, 2023). Agriculture, among the leading sectors of Pakistan's economy, employs 37.4% of the country's workforce and plays a pivotal role in ensuring food security & supplying raw materials to the industrial sector (ECONOMIC SURVEY OF PAKISTAN, 2023). Agriculture significantly underpins the economies of least developing countries such as Pakistan, constituting a fundamental cornerstone of its economic structure.

After United States, EU is Pakistan's second most important trading partner, accounting for 14.3% of Pakistan's total trade in 2020 and absorbing 28% of Pakistan's total exports (EUROPEAN COMMISSION, 2021). Pakistan ranks as the EU's 42nd largest trading partner accounting for 0.3% of EU trade. Pakistan's exports to the EU are dominated by textiles and clothing, accounting for 75.2% of its total exports to the EU in 2020. The growth of Pakistan exports to EU has been particularly fast since the award of EU's GSP+[11] status to Pakistan in 2013. Due to this special status Pakistan benefits from almost duty-free access for four of its products across all the EU 27 member states on 91% of tariff lines. This special arrangement has resulted in a significant upsurge in Pakistan's exports to the EU, with a remarkable 165% increase since its award. In 2021-22, Pakistan's exports to the EU amounted to USD 9.2 billion (ECONOMIC SURVEY OF PAKISTAN, 2023). Pakistan's imports from the EU are mainly comprised of machinery and transport equipment (33.5%) as well as chemicals (22.2%).

2.1.1 Role of agriculture in Pakistan's economy

Agriculture holds the position of one of the largest sectors in Pakistan's economy (PBS, 2022), with the majority of the population directly or indirectly relying on it. This sector contributes approximately 20% to the GDP and when combined with agro-based products, contributes to 80% of the country's total export earnings (AGRI-PUNJAB, 2022). It is assumed to have a multifaceted role in Pakistan's economy, encompassing food security, poverty alleviation, industrial development, and economic growth.

According to FAO (2023), covering an extensive area of 30.5 million hectares, agricultural land in Pakistan constitutes about 47% of the national territory, surpassing the global average of 38%. Within the agriculture sector, livestock holds a dominant share of 62%, followed by important crops (4.1%), other crops (3.3%), forestry (0.5%), and fisheries (0.3%). Pakistan experiences two major cropping seasons, Rabi[12] and Kharif[13], with a total water availability of 72.7 million acre-feet (MAF). Over 82% of cultivated land is irrigated, while 18% relies on rainfed conditions. Approximately 60% of rainfed areas are dedicated to cultivating winter-season crops such as wheat, barley, etc. Wheat and rice, accounting for 37% and 11% of the total crop area, are the two major crops. Sugarcane and cotton contribute 0.9%

[11] Under this EU's generalized scheme of preferences (GSP) program, eligible developing countries receive reduced tariffs or tariff-free access to the EU market for their exports. Pakistan receives substantial tariff preferences, primarily zero duties applied to around two-thirds of all product categories, through the GSP+ arrangement.

[12] Rabi crops are sown from October to December and encompass crops such as wheat, mustard, tobacco, barley, etc. Harvesting usually begins from April and extends through June.

[13] For Kharif crops, sowing typically starts in April and ends by June. Important crops are rice, cotton, maize and sugarcane, among others. Harvesting for these crops occurs between October and December.

and 0.3% to the GDP, respectively. According to FAO (2018), Pakistan held impressive rankings, standing at 4th in cotton production, 5th in sugarcane, 8th in wheat and 10th in rice production, respectively.

For 2023, Pakistan's agriculture sector's growth was estimated at approximately 1.55%, primarily attributed to the strong performance of key crops such as wheat, sugarcane, maize, and the livestock segment. Conversely, the industrial sector exhibited a negative growth rate of -2.94%, with its performance heavily contingent on the manufacturing sector, constituting 65.0% of the industry. The services sector has consistently comprised the largest share of the GDP, contributing 58%, and experienced a modest growth rate of 0.86% in the same period (ECONOMIC SURVEY OF PAKISTAN, 2023).

As reported by PBS (2023), Pakistan's GDP exhibited a fluctuating yet resilient trend across its economic sectors between 2018 and 2022 (Figure 2.3). The agricultural sector, contributing consistently around 21% to 23% of the GDP, displayed stability despite minor variations, hinting at potential advancements or enhanced productivity. Conversely, the industrial sector, maintaining a modest 18-20% share, showcased steady but restrained growth, while the services sector remained dominant, consistently contributing around 58-60% to the GDP.

Notably, the GDP growth rates reflected a 6.1% increase in 2018, a dip to 3.1% in 2019, a contraction at -0.9% in 2020 due to external shocks, followed by resurgence to 5.8% in 2021, and sustained growth rate of 6.1% in 2022, indicating a swift recovery and economic resilience. This diverse sectoral contribution and recovery momentum underscore Pakistan's ability to meet challenges and rebound, with the services sector playing a stabilizing role amidst the varying contributions of agriculture and industry to the country's economic landscape.

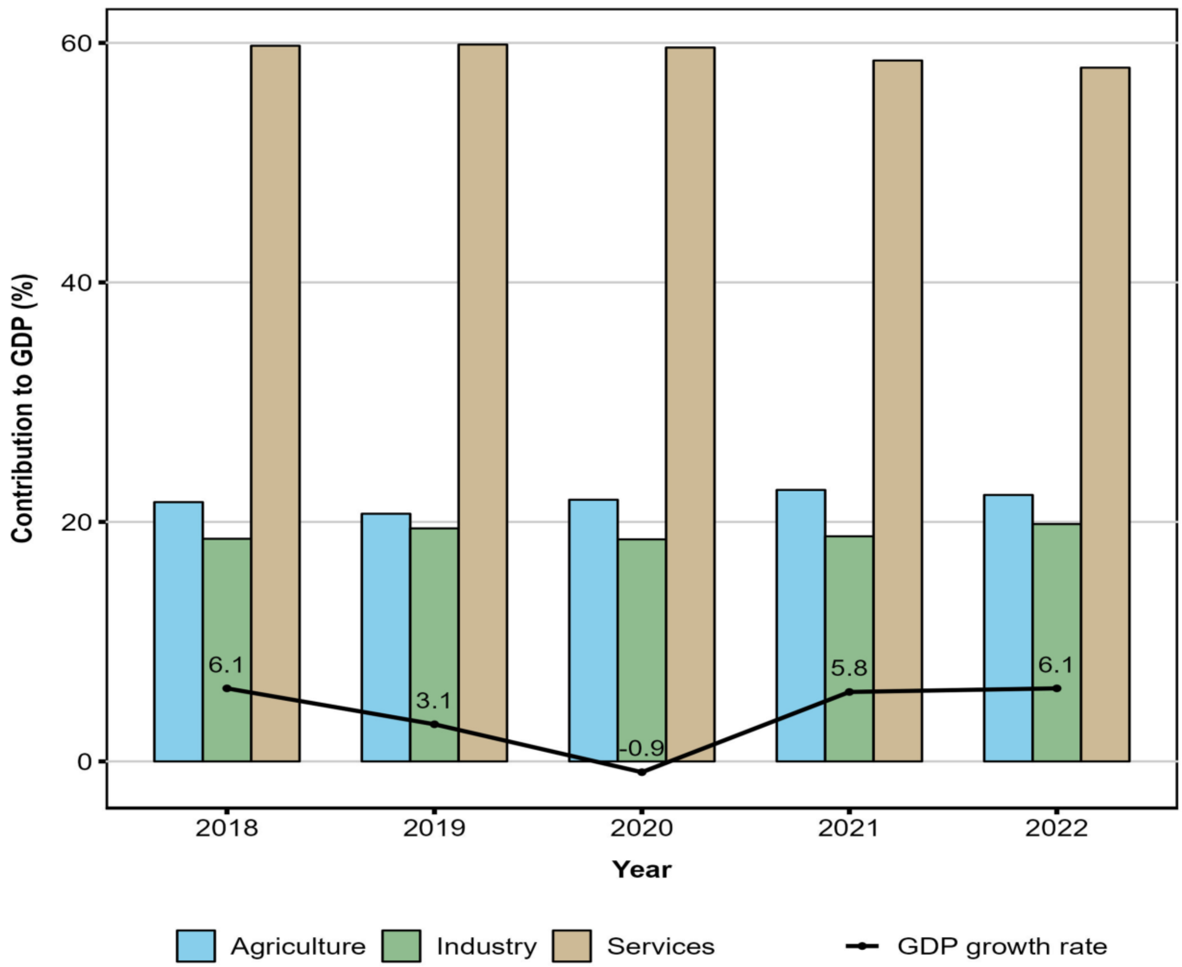

Figure 2.3: Contribution of economic sectors (%) in Pakistan's GDP (2018-2022)

Source: Pakistan Bureau of Statistics (PBS), 2023

2.1.2 Horticulture sector development

Agriculture in Pakistan encompasses various sub-sectors, including food crops (wheat and rice), cash crops (cotton and sugarcane), horticultural crops (mangoes, citrus, dates, apples, etc.), pulses, livestock, and poultry. Horticulture, with its export potential, has become a high-priority sub-sector in Pakistan (BABAR, 2014). Mango production, among other horticultural crops, holds a prominent position due to its domestic demand and the high potential to contribute significantly to the country's exports (GOVERNMENT OF PAKISTAN, 2010; HUSSAIN et al., 2010).

Mango (*Mangifera indica L.*), commonly referred to as the 'King of Fruits', holds the distinction of being the national fruit and ranks as the second most significant fruit crop cultivated in Pakistan in terms of both; cultivation area and production

(GHAFOOR et al., 2009; MALIK et al., 2010). Nonetheless, among the diverse mango varieties cultivated in Pakistan, Chaunsa and Sindhri stand out as the two most popular ones. As a leading mango-producing country, Pakistan heavily depends on the export of premium-quality mangoes, particularly the white Chaunsa variety, which makes a significant contribution to its economy. During the summer season, domestic demand for mangoes in Pakistan is exceptionally high. It holds a prominent place in the country's food culture, contributing to its widespread popularity (BADAR et al., 2015-2019).

According to FAOSTAT (2023), among the leading mango-producing countries worldwide, India retained its prominent position, producing 24.9 million tons of mangoes and accounting for 43.79% of the global production in 2021 (Table 2.1). Following India, China and Indonesia stood out, capturing 6.94% and 6.24% of the world mango production. Pakistan secured its place among the top producers, producing 2.6 million tons, contributing 4.69% to the world's mango production. In 2020, Pakistan's mango exports accounted for 2.16% of the global market, reaching a total value of USD 75 million (IMRAN et al., 2023). Notably, Mexico, Brazil, and Malawi also made substantial contributions.

Table 2.1: Pakistan and other leading mango-producing countries (2021)

Country	Production (ton)	Export quantity (ton)	Export value (1000 USD)	Share in world production (%)	Share in world export (%)
India	24,968,000	170,212	185,236	43.79	6.55
China	3,961,662	7,461	26,133	6.94	0.28
Indonesia	3,561,867	382	758	6.24	0.014
Pakistan	2,677,017	189,690	164,719	4.69	7.30
Mexico	2,441,495	429,391	506,151	4.28	16.53
Brazil	2,057,765	273,071	250,134	3.60	10.51
Malawi	1,696,121	520	1,602	2.97	0.02
Thailand	1,635,233	382,093	665,280	2.86	14.70
Bangladesh	1,458,554	1,136	3,187	2.55	0.043
Vietnam	1,439,272	96,000	286,000	2.52	3.69
Others	11,114,294	1,047,616	1,588,859	19.49	40.33
World	57,011,283	2,597,573	3,678,059	100.00	100.00

Source: Food and Agriculture Statistics (FAOSTAT), 2023

2.2 Mango production and its marketing system

Pakistan stands as one of the world's major agricultural countries, benefitting from its favorable climate for the commercial production of diverse fruit crops. Approximately 37.1% of Pakistan's land is dedicated to cultivating crops of agronomic and horticultural significance. Interestingly, the total area under horticultural crops constitutes less than 6% of the cultivated land. The average farm size for various horticultural crops, ranging from floriculture and fruit nurseries to orchards, is 3.1 hectares.

Province-wise analysis reveals that Punjab leads in both area and production, accounting for 47.4% and 63.2%, respectively. Balochistan follows with 13% in both categories, while Sindh contributes 25% in area and 14% in production. Khyber Pakhtunkhwa (KPK) stands at 13% in area and 10% in production (SHAH et al., 2022). The present production ranking of major fruits in Pakistan is as follows: citrus, mango, date, apple, guava, banana, and apricot.

Mango is primarily cultivated in Punjab and Sindh provinces. Pakistan mango season begins with Sindh's harvest in May and ends in Punjab in late August. Key varieties include Sindhri and Chaunsa, with additional types like Dosehri, Malda, Swarnarika, Langra, Siroli, Alphonso, Gulab Khas, Fajri, Golden, Anwar Ratol, and Began Phali; grown in various regions (PHDEB, 2005). In Punjab, significant quantities of mangoes are produced in major districts such as Multan, Rahim Yar Khan, Bahawalpur, Muzaffargarh, and Vehari. In Sindh, the primary centers of mango production include Tando Allahyar, Mirpur Khas, Naushehro Feroze, and Sanghar (MALIK et al., 2010; BADAR, 2015).

Table 2.2 presents the province-wise and overall production of mangoes in Pakistan in recent years. It can be observed that Punjab consistently dominates in mango production, contributing significantly to the overall production. Sindh shows variability but has been maintaining a substantial contribution. Khyber Pakhtunkhwa and Balochistan, while producing smaller quantities, contribute to the diversity of mango sources. The total national production has experienced fluctuations, with notable peaks in 2010-11 and 2021-22. According to PFVA (2023), 50% of mangoes from Pakistan are exported by sea, 35% by land, and 15% by air.

Table 2.2: Province-wise mango production (1000 tons) in Pakistan (2010-2022)

Years	Punjab	Sindh	Khyber Pakhtunkhwa	Balochistan	Pakistan
2010-11	1,503.20	381.30	2.90	1.10	1,888.50
2011-12	1,304.20	391.80	2.90	1.20	1,700.10
2012-13	1,280.20	396.10	3.00	1.10	1,680.40
2013-14	1,252.00	402.50	3.00	1.10	1,658.60
2014-15	1,313.60	399.20	3.00	1.10	1,716.90
2015-16	1,227.95	404.18	3.10	1.25	1,636.47
2016-17	1,375.03	404.87	3.05	1.14	1,784.09
2017-18	1,329.30	400.50	3.00	1.14	1,733.94
2018-19	1,330.17	387.88	3.32	1.31	1,722.68
2019-20	1,304.30	329.30	3.60	1.70	1,638.90
2020-21	1,321.46	386.97	3.60	1.78	1,713.81
2021-22	1,450.44	387.40	3.50	3.36	1,844.71

Source: Agriculture statistics of Pakistan (various issues)

The mango production in Pakistan has undergone significant changes over the past decades (Table 2.3). Despite the reduction in cultivation area during 2015-20 compared to previous periods, the total production remained robust at 1,719.03 thousand tons. The impressive increase in yield during 2015-20, reached at an amount of 25.41 tons per hectare. This unexpected increase in productivity can be because of advancements in cultivation practices, technology adoption, the introduction of high-yielding mango varieties, or possibly change in the survey method adopted during this time period.

Table 2.3: Pakistan mango cultivation area, production, and yield (2000-2020)

Year	Cultivated area (1000 hectare)	Total production (1000 tons)	Yield (tons/hectare)
2000-05	110.68	1,157.73	10.46
2005-10	166.24	1,760.04	10.58
2010-15	172.11	1,728.38	10.04
2015-20	67.63	1,719.03	25.41

Source: SHAH et al., (2022)

2.2.1 Pakistan mango supply chain

The mango industry, similar to other agro-food industries in Pakistan, consists of diverse groups forming chains connecting input suppliers to final consumers. Profit is generated by linking businesses upstream with those downstream. In this process, these businesses influence the flow of products, information, and money in the value chain. Broadly categorized as traditional, modern, or export supply chains, these chains are distinguished by the types of retailers and target markets they serve (BADAR et al., 2019). While these value chains operate independently to target their respective markets, they also coexist and collaborate to fulfill demand and supply gaps. In developing countries, as highlighted by RUBEN et al. (2007) and TRIENEKENS (2011), these three types of chains are common.

Traditional value chains dominate the mango industry in Pakistan, with the majority of production flowing through unorganized, fragmented, and relatively lengthy chains. In traditional chains, mangoes often pass through more than five middlemen before reaching to end consumers. Street vendors and roadside sellers, serving the needs of most consumers, are common in these chains. However, these traditional supply chains often lack adequate infrastructure, leading to poor fruit handling & management practices which result in low to medium value creation across various stages. Mango grading is based on a simple visual assessment of size, resulting in varying fruit quality from poor to good in terms of size, shape, color, cleanliness, and free from blemishes & damages. Prices, determined on daily basis demand and supply of the fruit, are much lower than in modern and export chains. Spot market transactions govern traditional chains, characterized by lower levels of coordination and poor information sharing among its actors.

The advent of modern retail formats, including supermarkets, in Pakistan has given rise to modern value chains in the agro-food industry (GHANI, 2005; VORLEY et al., 2016). BADAR et al., (2019) study's findings indicate that these modern value chains are also making inroads into the Pakistan mango industry. Modern retailers such as mega stores, supermarkets, and special fruit shops cater to the needs of middle and high-income consumers. Currently, a smaller proportion of mangoes pass through these value chains, but their share is anticipated to grow as more consumers opt for them due to their high-quality produce and cleaner environment. Modern retailers typically have refrigerators and storage facilities to maintain fruit quality.

The export value chain concentrates on the export market, responding to the demands of buyers from other countries. These chains typically handle relatively high-quality mangoes, graded and packed in various sizes. The level of value creation in export chains is comparatively high. However, despite this, Pakistan mangoes often fetch lower prices in international market. This is mainly attributed to their short shelf life, stemming from subpar postharvest practices and challenges in consistently meeting international standards (DUNNE & JOHNSON, 2010; XIMING SUN et al., 2011).

In all three chains, the product flows originate in the orchards where growers nurture mango trees from nursery seedlings, either raising them independently or acquiring them from fellow growers or private nurseries by applying inputs like fertilizers, pesticides, and water (see Figure 2.4). Typically, growers sell their standing mango crops to pre-harvest contractors at the maturing stage, relieving them of responsibilities such as harvesting and marketing. Contractors handle the harvesting, pack the mature unripe mangoes in wooden boxes, and transport them to commission agents in various wholesale markets across the country. Larger growers may take charge of harvesting and marketing operations themselves.

In fruit and vegetable wholesale markets, commission agents conduct auctions of mangoes for wholesalers, typically in large lots. These lots generally consist of 30 to 50 crates, each weighing 10 to 12 kg. Wholesalers unpack the crates and use calcium carbide to initiate ripening. After three to four days, when the mangoes are ripened, wholesalers sell them in smaller lots or individual crates to retailers, who then transport the mango crates from the market to their outlets. Following re-grading, retailers sell mangoes directly to consumers. According to BABAR (2015), consumers often express dissatisfaction with the mango quality due to the use of calcium carbide for ripening, retailer malpractices, and ineffective government regulations, particularly in terms of food safety and high mango prices.

In the case of export value chains, mangoes are directly transferred from growers and contractors to exporters. Exporters take charge of transporting mangoes from orchards to their export facilities, where high-quality graded mangoes undergo separation. Lower-quality mangoes are either discarded or sold at reduced prices in local markets. After grading, processing, and packing, exporters ship these mangoes by sea in containers to nearby markets like the Middle East, or by air to distant markets such as USA, UK and the EU.

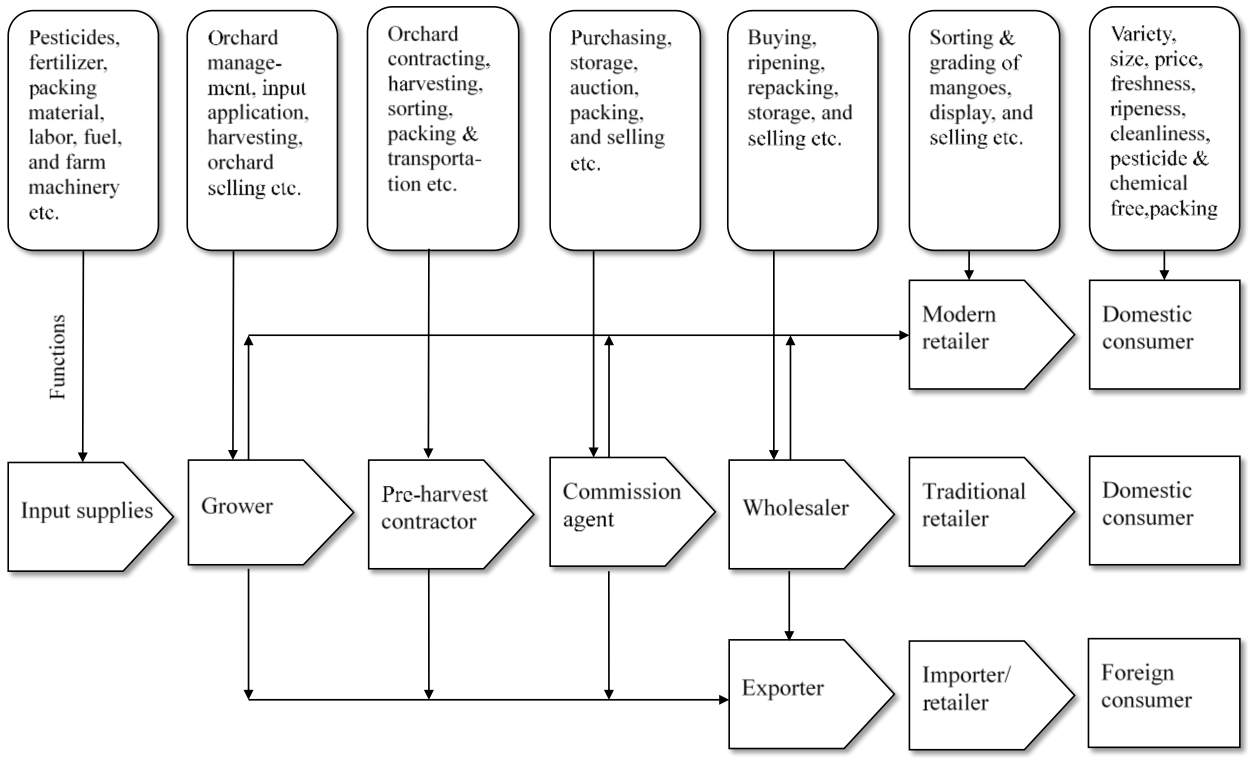

Figure 2.4: Structure of value chains in Pakistan's mango industry

Source: Author's illustration

2.2.2 Mango export performance and its major destinations

Pakistan's annual mango exports reach approximately 150,000 metric tons, with primary destinations in the Middle East, the EU, the US, Japan, Australia, and various other countries. This contributes around 90 to 100 million dollars annually to the national revenue. According to HAYDER (2023), the UAE stands out as one of the top export destinations for Pakistan's mangoes, with exports reaching millions of dollars during the three-month season. Furthermore, it's highlighted that Pakistan's mangoes contribute to less than 0.36% of China's total mango imports. In 2022, Pakistan exported only 23.95 metric tons of fresh or dried mangoes to China, with a total value of USD 55,605. This marked a decrease from 37.42 metric tons of value USD 127,200 in 2021 (OLGA, 2023). Nevertheless, Pakistan's mango industry is making concrete efforts to promote its fruit in China. Several proposed investments are aimed to improve orchard management, farm hygiene, cold chain transportation, and marketing. These endeavors are geared to enhance the Pakistan mango industry's capacity to effectively meet China's import requirements.

Table 2.4: Pakistan's mango export to top ten countries (2022)

Countries	Quantity (ton)	Value (1000 Rs)	Value (1000 USD)	Value (USD/kg)
UAE	50,536	6,101,183	29,826	0.59
Kazakhstan	34,139	3,967,582	19,396	0.57
Afghanistan	13,972	1,429,358	6,987	0.50
Oman	12,939	1,566,244	7,657	0.59
UK	7,885	4,784,383	23,389	2.97
Uzbekistan	7,634	928,576	4,539	0.59
Qatar	5,668	943,191	4,611	0.81
Saudi Arabia	3,832	802,708	3,924	1.02
Bahrain	1,739	329,337	1,610	0.93
Germany	1,109	577,131	2,821	2.54
Others	6,454	2,835,326	13,861	2.15
Total	145,907	24,265,019	118,621	0.81

Note: Average exchange rate for 2022: 1 USD = Rs 204.56
Source: Pakistan Bureau of Statistics (PBS), 2023

2.3 Pakistan mango export to the European market and its issues

Pakistan's annual mango production capacity typically reaches around 1.8 million tons but it fluctuates due to the evolving climate and market conditions. Changes in weather patterns disrupt the normal life cycle of mangoes, affecting tree health and, consequently, fruit quality. In 2023, the crop faced challenges from fruit malformation, hoppers, and heavy rains at fruit ripening stage in certain areas, potentially compromising size and quality (HANIF, 2023). According to statistics of PFVA (2023), the mango crop has experienced adverse effects of climate change in the country, with a 20% reduction in anticipated production. The extended winter and delayed onset of summer are contributing to the decline in mango production, accompanied by a weakened ability to combat diseases in mango orchards. The PFVA suggests that research institutes and provincial agriculture departments should provide resources and awareness to mango farmers to mitigate the negative impacts of climate change. Similarly, low market prices and inadequate treatment facilities also impact mango production to some extent.

2.3.1 Farm-related issues and quality control

In Pakistan, fruit cultivation faces challenges due to soil salinity and alkalinity, which limit water availability despite aiding nutrient access for plants. Concerns arise from water contamination by urban and industrial waste, impacting both plant and consumer health. Flooding orchards for irrigation emerge as a key method to reclaim soil affected by salinity and alkalinity (WAQAR & NADEEM, 2013). Water shortages and the unavailability of diesel and electricity to operate tube wells are cited as additional factors (LATIF, 2022) for the decline in mango production. At farm levels, another major challenge is inadequate physical infrastructure, particularly in terms of road connectivity between farms and markets.

Diseases play a significant role in diminishing orchard yields, with infected nurseries being a primary source of pathogen dissemination. Poorly regulated and uncertified nurseries contribute to various orchard problems. The lack of regulations results in untrained and non-technical nurserymen, compromising the provision of true-to-type plant seedlings to farmers and reducing the potential of elite fruit varieties. Exotic plant material, often not evaluated for diseases, poses risks to human health. Additionally, the unavailability of quality seeds emerges as a key limiting factor for achieving high yields and quality in major fruit crops (SHAH et al., 2022). Achieving success in fruit crops hinges on proper nutrition and effective pest management. Unfortunately, this aspect faces significant challenges, primarily stemming from a lack of education and technical support from extension departments and allied research organizations (AUJLA et al., 2007).

The mango business in Europe poses challenges for both importers and exporters due to fruit quality issues, phytosanitary checks, and unpredictable supplies. For Pakistan, establishing a reliable supply is crucial, and the most profitable approach is to integrate it into a retail supply program. This strategy helps navigate the seasonal competition from major suppliers like Brazil and Peru. Mangoes also pose a high risk for fruit flies (*Tephritidae*), necessitating a phytosanitary document for exporting to the EU. Standard hydrothermal treatments (hot water treatment) are required before export. The stringent requirements in this phytosanitary certificate place additional pressure on plant health authorities. Authorities in producing countries must declare a region pest-free or conduct thorough checks on specific areas and product treatments. The insufficient capacity of local authorities for phytosanitary control impacts the export potential of fresh mangoes to the EU.

2.3.2 Logistical problems

Despite significant increases in mango area, production, and exports over time, the performance of the mango industry in Pakistan remains sub-optimal. Technical challenges such as low productivity, inadequate production and post-harvest losses, the absence of modern cold storage and pack-house infrastructure, along with deficiencies in diseases & pest management contribute to the industry's struggles (CAMPBELL et al., 2009; COLLINS & IQBAL, 2010; NAFEES et al., 2013). Pakistan targets specific market segments in the EU, by exporting special mango varieties like Chaunsa, Sindhri and Anwar ratol. These unique varieties often rely on air logistics, and soaring air freight rates pose serious challenges for exporters. As per FAO (2022), mango exports from Pakistan had a 24% decline in shipments in 2022, amounting to 110,000 tons. This decrease is attributed to several factors such as harsh weather conditions during production stage, inadequate post-harvest fruit handling facilities and high international freight rates. With gradual logistics improvement, it can be anticipated that export supply will recover in the coming years.

2.3.3 Institutional and policy level challenges

The inefficiency of public sector trade promotion institutions, particularly TDAP[14] and PHDEC[15], has hindered the expected progress and development of the mango industry. The failure stems from a lack of innovative problem-solving approaches and inadequate coordination among promotional entities within the horticulture sector. Several causes contribute to this underperformance, including corruption, political interference, low wages and lack of strategic direction and leadership (TRTA, 2014). In 2017, efforts were made to restructure the organization to enable PHDEC to effectively pursue its dual strategy for developing and exporting Pakistan's horticulture products (AZAM & SHAFIQUE, 2017).

Additionally, exporters are urging the custom department to adopt a more supportive approach towards trade, highlighting concerns about the department's alleged highhandedness and mismanagement of perishable shipments. Criticism is directed at the random selection of shipments by WeBOC officials for inspection, leading to the containers being physically checked on ground. Allegations suggest that even reefer containers are opened and left unplugged during this process, causing a thermal shock that deteriorates the quality of the fruit (TRTA, 2014).

[14] Trade Development Authority of Pakistan (TDAP) serves as Pakistan's public sector leading trade organization, overseeing trade policy initiatives, fostering export development across the industries, organizing trade delegations, and arranging local and international trade exhibitions.

[15] Pakistan Horticulture Development and Export Company (PHDEC) supports the Pakistan’s horticulture sector promotion.

The inspection process for exports in Pakistan, mandated to be completed within 12 hours, often exceeds this timeframe, commonly taking between 24 to 48 hours. Custom officials conduct inspections, but in addition, the anti-narcotics force carries out independent inspections of shipments. Exporters are responsible for covering all costs associated with these inspections, despite the delays that can occur in the clearance process. According to the law, the primary role of the custom department in Pakistan is to verify and ensure that the required documentation for a consignment is complete and accurate. Additionally, they are responsible for collecting the appropriate fees and duties associated with the shipment.

ABBAS (2023) revealed concerns among licensed owners of hot water treatment plants regarding a single company handling 75% of total mango exports, suggesting potential favoritism by department of plant protection (DPP) officials. Documents indicated that for exports to EU, only 26% (33,708 million tons) of the total mango exports (130,221 million tons) received treatment, while a majority of untreated mangoes were sent to the UAE, due to the lack of hot water treatment (HWT) facility. This situation emphasizes the necessity for stringent measures and adherence to international standards to protect mango export industry amid escalating phyto-related concerns.

3 RESEARCH DESIGN AND SOCIO-ECONOMIC CHARACTERISTICS

This chapter is composed of the general framework of the research design, selection of study areas, data collection procedure, the types of data collected, and the variables description, used later on for different analyses in the study. The background information of the sample exporters and other key actors of the mango export supply chain is also provided. By using both primary and secondary data, important descriptive statistics of sample exporters' socio-economic characteristics and mango export markets are presented to give an overview of the study.

3.1 Research design and data collection

3.1.1 Framework of the research design

The overall analytical framework of the research is presented in Figure 3.1. The framework starts with the literature review, identification of the research problem, specification of the research questions & objectives, the theoretical conceptualization of the research, analytical methodology, selection of study areas, formalization of different sources of primary & secondary data, and ends with the research findings. This study is mainly based on Pakistan mango exporters' survey data to characterize their export performance for three different markets viz; Aggregate, Specialized–EU, and Diversified–EU (see Table 3.9 for definitions).

Factors affecting their export efficiency and profitability are investigated for these markets by using different analytical approaches. Considering it is a high-value market, the import demand of Pakistan mango and its comparative advantage over other leading exporters to the EU market is investigated by using secondary data. To determine the role of logistics in Pakistan mango exports to the European market and exporters' behavior of transport mode choice, a comprehensive analysis of discrete choice experiment (DCE) is also performed by using the data collected through choice cards.

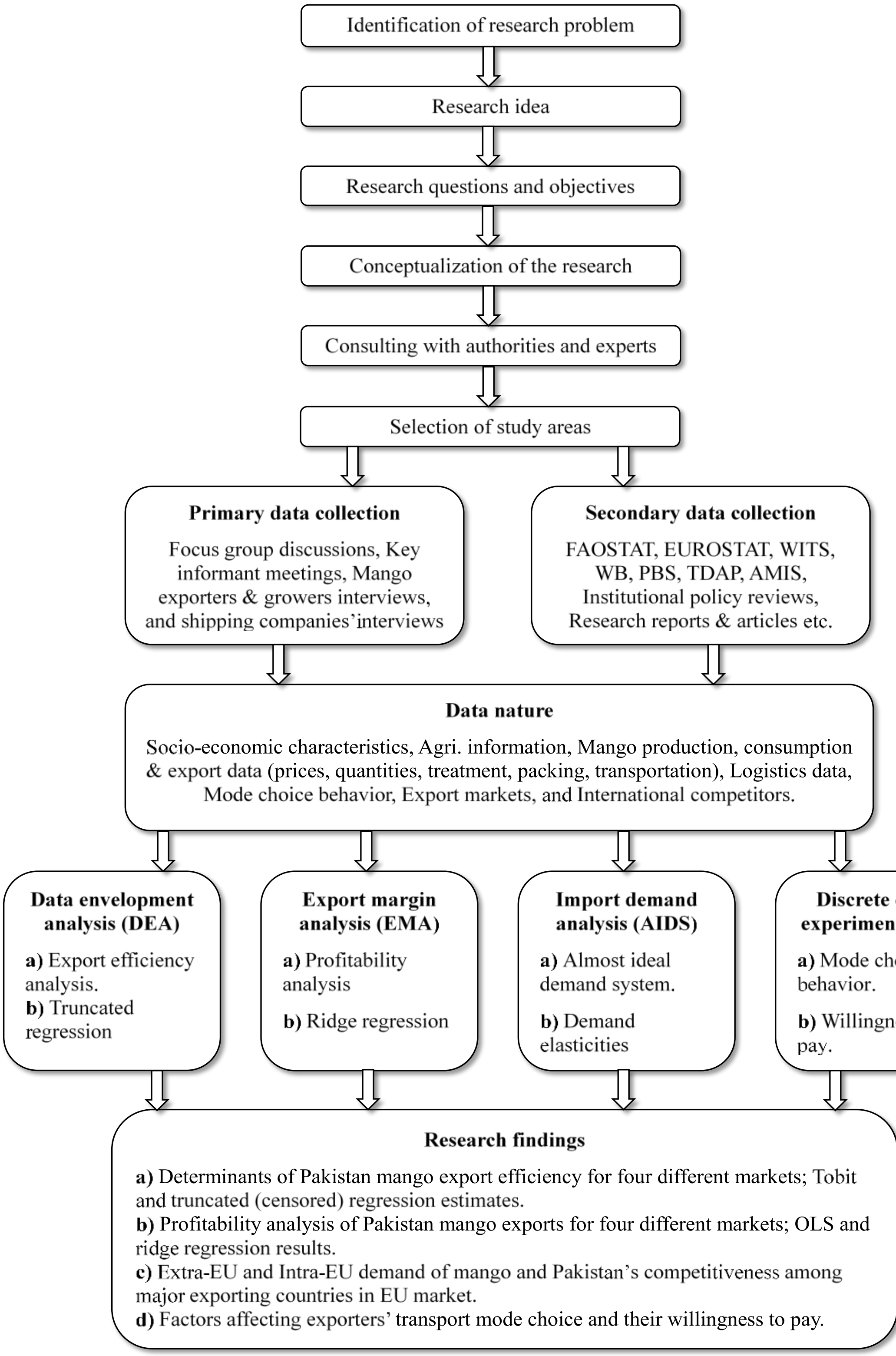

Figure 3.1: Framework of the research design for the study

Source: Author's illustration

3.1.2 Consulting with authorities and key stakeholders

Before conducting the mango exporters' survey, preliminary discussion meetings were organized with the export-related institutional authorities, researchers, academicians, and subject experts to develop a policy-level understanding of the research at hand. Focus group discussions (FGD) were held with the mango growers, exporters, shipping companies, and the management of the Pakistan fruit & vegetable exporters' association (PFVEA) to determine the challenges in the Pakistan mango export supply chain, especially for the EU market. During this consultation process with the key stakeholders (both from public and private sectors), background information on the possible study areas and sample cities was collected. After incorporating the valuable suggestions of experts and business practitioners, a pilot survey was conducted to check the appropriateness of the questionnaire and choice cards. The survey questionnaire was then revised, edited, and updated to get the required information at the exporter level.

3.1.3 Selection and description of study areas

Pakistan is one of the largest horticulture-producing countries with a 5% share in agriculture. In 2020-21, it produced around 14.4 million tons of different fruit and vegetables on 1.52 million hectares of land (MINISTRY OF NATIONAL FOOD SECURITY AND RESEARCH, 2021). Pakistan is the 5th largest producer of mango in the world with over 200 varieties cultivation. Mango is the 2nd largest fruit crop in Pakistan after citrus with it's a 4.5% share in world production (FAO, 2020). Punjab and Sindh together contribute about 89% of Pakistan's total mango production (GOVERNMENT OF PAKISTAN, 2021). Punjab accounts for 62% of mango acreage, Sindh accounts for 32% while the rest of the 6% is accounted for in other regions of the country. The share in the country's total mango production by Punjab and Sindh accounts for 67% and 26%, respectively (PAKISTAN ECONOMIC SURVEY, 2021). Within Pakistan, Punjab enjoys the highest yield rate of mango, 13 tons/hectare followed by Sindh, 6 tons/hectare. Multan, Muzaffar Garh, Rahim Yar Khan, Bahawalpur, Lodhran and Vehari are leading mango-producing districts in Punjab. In Sindh, the districts of Sanghar, Mirpur Khas, Tando Allah Yar, Tando Muhammad Khan, Jamshoro, and Hyderabad produce most of the mangoes (GOVERNMENT OF PAKISTAN, 2021).

Given the importance of the aforementioned mango growing regions, a total of 9 mango-producing districts (4 out of Punjab and 5 out of Sindh) along with Karachi and Lahore were selected for the survey (Figure 3.2). Karachi and Lahore cities were selected because of being the country's two biggest wholesale markets of fruit &

vegetable trading. Another reason for selecting these two cities as study areas is that most of the mango traders (exporters) are based in these cities. Furthermore, because of their high business volume, these two wholesale markets are considered as the "origin point" of the daily market price of fruits & vegetables in the country (for local as well as export marketing). During the survey, it was also observed that most of the export processing facilities are situated in these two districts.

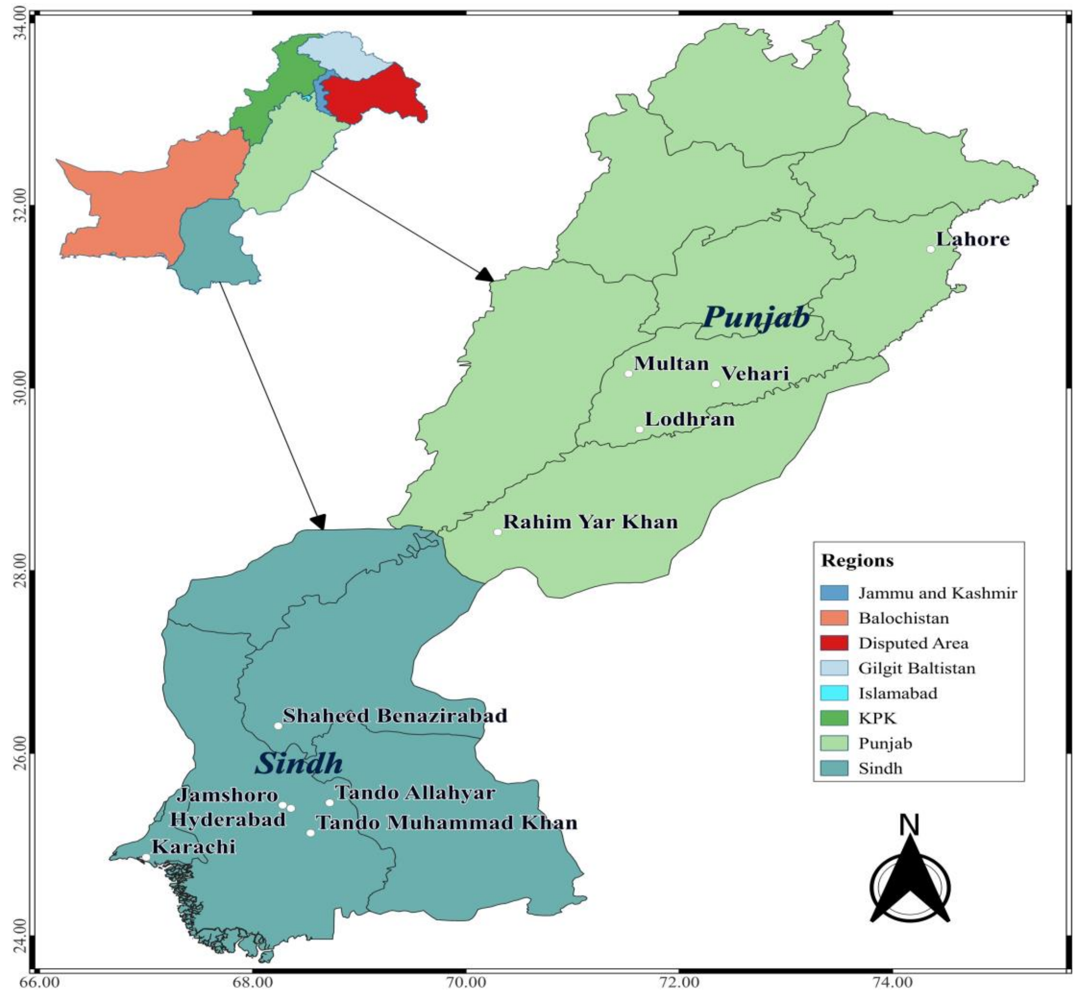

Figure 3.2: Study area map of Pakistan

Source: Author's illustration based on Diva-GIS data and using QGIS 3.28.1

3.1.4 Sampling procedure and data collection

Punjab and Sindh provinces were purposively selected to conduct field survey for this research, based on the information about their major mango growing areas and exporting hubs. A total of 11 districts from these two provinces (Figure 3.2) were visited and primary data was collected by using the pre-tested questionnaire during the time period of June to August 2014 (Pakistan mango season). Mango exporter was the sample respondent in this data collection. Additionally, some other key actors of the mango export supply chain like grower, commission agent, wholesaler, treatment plant facility owner, and clearing and freight forwarding agent were also visited to collect vital information about the overall export process.

As a primary data source, the total sample size of this study is 100 mango exporting firms. In order to ensure the data quality, owners of these exporting firms or their representatives were interviewed in person by the author of this study and no enumerator was hired for the data collection. The dataset of these 100 mango exporters comprises of two types of exporters, 1) sole exporters; those who buy mango directly from the wholesale market (or orchard) for export purposes, and 2) grower-cum exporters; those who own an orchard, grow mangoes, and do the export. Grower-cum exporters mainly export their own product or sometimes buy from another orchard. Out of this total sample size of 100 exporters, 72 are sole exporters and 28 are grower-cum exporters. Furthermore, 20 shipping companies' representatives (13 airlines & 7 shipping lines) were also interviewed to exactly understand the perspective and role of international logistics services in an export supply chain of a perishable commodity like mango.

By using the simple random sampling method, sample exporters were selected for the interview. As the study is designed to focus mainly on Pakistan mango exporters' efficiency for the European market, so only those respondents were included in the sample set who were exporting to the EU market, they can be either Specialized–EU exporters (exporting only to the EU market) or Diversified–EU exporters (exporting to non-EU market also along with the EU market). Exporters exporting only to non-EU markets were dropped at the selection stage. In the total sample size of 100 firms, 44 firms were found to be involved in Specialized–EU exports while 56 were doing Diversified–EU exports.

Hence, to investigate the export performance of Pakistani mango exporters for the EU market (and other markets also), firm-level data was collected. Demographic and socio-economic characteristics of mango exporters (or firms) such as age, education, experience, labor, working capital, business volume, sources of procurement, target markets, mango treatment and its verification, loss & damage, sanitary and phytosanitary protocols, packing material, shipment clearing & freight forwarding procedures, institutional support, different types of costs at each step of the export value chain and export prices were recorded in the field survey. To determine the factors affecting the exporters' decision to use the transport, required data were collected by conducting an in-depth Discrete Choice Experiment (DCE). As mango is a perishable commodity, special attention was paid to collect qualitative data also regarding mango characteristics, physiological changes during the shipping stage and its limitations, exporters' perception of logistical challenges, and future use of transport modes, particularly for distant markets like the EU.

Secondary data regarding Pakistan's trade policies, historical trends in mango production & its exports to the EU market, other leading countries' exports to the EU, export price competitiveness, and mango re-exporting patterns within the EU market were collected from both national and international sources. Within Pakistan, statistical information was obtained by having a direct request to the Department of Agriculture (DOA), Agricultural Marketing and Information Services (AMIS), Pakistan Bureau of Statistics (PBS), Pakistan Horticulture Development and Export Board (PHDEB), Trade Development Authority of Pakistan (TDAP), and Pakistan Customs. From international sources, data was mainly obtained by having internet access to the Food and Agriculture Statistics (FAOSTAT), Statistics Office of the European Commission (EUROSTAT), the World Bank (WB), and UN Comtrade. Additionally; recent research articles, statistical yearbooks, the Pakistan Economic Survey (PES), different progress reports, and bulletins were also reviewed to get the necessary information.

After completing the data entry in MS Office Excel, necessary data cleaning and editing were done. A set of three different softwares is used in this research. Firstly, to conduct the choice experiment, choice cards were developed by using the software Ngene 1.1.2 before going for the field survey. Secondly, STATA 12 was utilized to estimate the discrete choice models. Lastly, R programming was used for the rest of the econometric analyses. Descriptive analysis is done to highlight the socio-economic characteristics based on the cross-sectional data obtained from the field survey and the secondary data.

3.2 Descriptive characteristics of exporting firms and shipping services

In this section, the descriptive characteristics that define both the exporting firms and the integral shipping services opted by the exporters within the mango export industry are explored. A fundamental understanding of these characteristics is essential for illuminating the dynamics of the mango export sector. By observing key variables and their impacts, it aims to study the operational pattern of exporting firms and the essential role played by shipping services.

3.2.1 Demographic characteristics of sample exporters

Frequency distribution of two important variables, age and exporter type, has been investigated first (Table 3.1). It is aimed to gain insights into the composition of firm owners and their propensity to engage as either sole exporters or grower-cum exporters. It is observed that the 36-49 age group has the highest percentage of sole exporters, indicating that individuals in this age range may be more inclined to operate as independent exporters. In contrast, the age group 49-62, stands out for a high proportion of grower-cum exporters, suggesting that older exporters prefer to export in group by sharing experience and resources.

The average age of the exporters in the study sample is 46 years. Against the null hypothesis that there is no significant difference in the age of exporter types, the two-sample t-test yielded statistics of -1.84*, which rejected the null hypothesis, indicating that there exists a significant difference in the average age between exporter types. This result suggests that, on average, grower-cum exporters tend to be older (50.60) compared to sole exporters (45.47) within the mango export industry. This disparity in age distribution may be indicative of varying levels of experience, expertise, and strategies between these two groups.

Table 3.1: Frequency distribution of sample exporters' age (years)

Age categories	Exporter type		Total (%)
	Sole (%)	Grower-cum (%)	
(22-36)	21.33	20.00	21.00
(36-49)	48.00	20.00	41.00
(49-62)	22.67	44.00	28.00
>62	8.00	16.00	10.00
Mean of all groups	45.47	50.60	46.75
t-statistic			-1.84 *

Note: *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively.
Source: Author's calculations

The second demographic characteristic of the exporters is education. Exporters in both sole and grower-cum categories exhibit diverse educational qualifications. A higher percentage (45.33) of sole exporters has 5-10 years of education. In contrast, grower-cum exporters have a higher representation in the 10-16 educational years, accounting for a substantial 76%, demonstrating that a large number of grower-cum exporters have pursued higher levels of education.

The data reveals a notable discrepancy in the average education between sole and grower-cum exporters. Grower-cum exporters, with an average education level of 12.64, tend to have a higher educational qualification compared to sole exporters, whose average education level is 9.68. The significant test statistic for the two-sample t-test analysis confirms this finding against the hypothesis that there is no difference in the mean education level between these two groups.

Table 3.2: Frequency distribution of sample exporters' education (years)

Education categories	Exporter type		Total (%)
	Sole (%)	Grower-cum (%)	
(0-5)	18.67	8.00	16.00
(5-10)	45.33	16.00	38.00
(10-16)	36.00	76.00	46.00
Mean of all groups	9.68	12.64	10.42
t-statistic			-3.58 ***

Note: *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively.
Source: Author's calculations

Table 3.3 provides an in-detail breakdown of exporters' experience, categorized by exporter type. The experience categories span from 0-10 years to over 30 years. Notably, the majority of both sole and grower-cum exporters fall within the 0-10 years of experience category, with 41.33% and 72%, respectively. This indicates that a significant proportion of firm owners in both categories are relatively new entrants to the mango industry. Interestingly, there is a small percentage of firm owners in (20-30) and more than 30 years of experience groups in grower-cum exporter category as compared to sole exporters. Moreover, it is found that the average experience of exporters is 14 years.

Lastly, for testing the hypothesis whether sole and grower-cum exporters have same experience, the t-test statistic of 2.03 indicated a significant difference in the average experience between exporter types. This result suggests that, on average, sole exporters have significantly higher experience compared to grower-cum exporters within the mango export industry. This difference in experience levels may indicate variations in skill development, industry knowledge, and strategies between these two groups.

Table 3.3: Frequency distribution of sample exporters' experience (years)

Experience categories	Exporter type		Total (%)
	Sole (%)	Grower-cum (%)	
(0-10)	41.33	72.00	49.00
(10-20)	33.33	20.00	30.00
(20-30)	17.33	4.00	14.00
>30	8.00	4.00	7.00
Mean of all groups	15.17	10.56	14.02
t-statistic			2.03 **

Note: *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively.
Source: Author's calculations

3.2.2 Firms' characteristics and types of exporters

In this section, a descriptive analysis of the mango exporting firms' characteristics has been explored. These firm-level characteristics play an important role in shaping the operational dynamics and strategies within the mango export industry. Hence, a comprehensive overview of the exporting firms' characteristics has been presented, highlighting the factors influencing their success and growth within the mango export sector.

The frequency distribution of firms' average working capital[16] presents categories ranging from 0-50 to >200 million rupees (see Table 3.4). Notably, there is a substantial difference in the distribution of average working capital between sole and grower-cum exporters. Sole exporters predominantly fall into the 0-50 million rupees category, accounting for 90.67% of this group. In contrast, grower-cum exporters display a more balanced distribution, with 28% falling into each category; 0-50, 50-100, and >200, indicating potentially higher resources. Irrespective of the exporter type, the mean working capital of firms in the study sample is 75.35 million rupees.

To confirm whether the average working capital is same across the exporter types, the two-sample t-test yielded a statistic of -3.37, which underscores a significant difference in the mean working capital between sole and grower-cum exporters. Specifically, the mean of working capital for sole exporters is 30.07 million rupees, whereas grower-cum exporters have a notably higher mean working capital of 211.20 million rupees.

[16] Working capital, a fundamental financial metric, reflects the financial and material resources at the disposal of mango exporting firms. It is a pivotal determinant of a firm's financial capacity and strategic flexibility.

Table 3.4: Frequency distribution of exporting firms' working capital (million Rs)

Average working capital categories	Exporter type		Total (%)
	Sole (%)	Grower-cum (%)	
(0-50)	90.67	28.00	75.00
(50-100)	5.33	28.00	11.00
(100-150)	0.00	8.00	2.00
(150-200)	1.33	8.00	3.00
>200	2.67	28.00	9.00
Mean of all groups	30.07	211.20	75.35
t-statistic			-3.37 ***

Note: *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively.
Source: Author's calculations

The frequency distribution of firms' total workers w.r.t exporter type is presented in Table 3.5. It reveals various categories ranging from 0-25 to >100 workers, signifying the exporting firms' size of workforce. Each exporter type has a notable percentage of firms with 0-25 workers, with 92% for sole exporters and 80% for grower-cum exporters. Notably, grower-cum exporters also have a higher representation in the rest of the workers' categories, especially in 25-50 and 50-75 categories with 8% each, whereas sole exporters have 1.33% and 4% in the same categories. Overall, the average of the total workers for exporting firms is 65.99.

The average of total workers for the sole exporter category is 50.81, while grower-cum exporters have a higher average of 111.52. To confirm whether the grower-cum exporters have significantly high numbers of workers than sole exporters, the non-significant two-sample t-test suggests that there is no significant difference in the mean total workers between exporter types. This non-significance can be attributed to less variability between the exporter types in terms of workers categories.

Table 3.5: Frequency distribution of exporting firms' total workers (number)

Total workers categories	Exporter type		Total (%)
	Sole (%)	Grower-cum (%)	
(0-25)	92.00	80.00	89.00
(25-50)	1.33	8.00	3.00
(50-75)	4.00	8.00	5.00
>100	2.66	4.00	3.00
Mean of all groups	50.81	111.52	65.99
t-statistic			-1.35

Note: *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively.
Source: Author's calculations

Table 3.6 displays the frequency distribution of firms' packhouse capacity ranging from 0-50 to >150 ton/day, with variations in the distribution of packhouse capacity between sole and grower-cum exporters. These categories represent the capacity of packhouses within exporting firms, a crucial determinant of their processing and packaging capabilities. Both groups have a significant presence in the 0-50 tons/day, with 81.33% for sole exporters and 60% for grower-cum exporters. The average packhouse capacity for all firms is found to be 91.34 tons/day.

The two-sample t-test to investigate whether there is a significant difference in the mean packhouse capacity between sole and grower-cum exporters is suggesting that there is no significant difference in the average packhouse capacity between these groups. Specifically, the mean packhouse capacity for sole exporters is 77.68 tons/day, while grower-cum exporters have a slightly higher capacity of 132.32 tons/day.

Table 3.6: Frequency distribution of exporting firms' packhouse capacity (ton/day)

Packhouse capacity Categories	Exporter type		Total (%)
	Sole (%)	Grower-cum (%)	
(0-50)	81.33	60.00	76.00
(50-100)	10.67	20.00	13.00
(100-150)	1.33	4.00	2.00
>150	6.67	16.00	9.00
Mean of all groups	77.68	132.32	91.34
t-statistic			-1.04

Note: *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively.
Source: Author's calculations

Table 3.7 presents a high degree of homogeneity in number of shipments between sole and grower-cum exporters. Most of the firms in both categories predominantly fall within the 0-25 shipments per season category, with 57.33% of sole exporters and 52% of grower-cum exporters. This indicates that a significant proportion of mango exporting firms, regardless of exporter types; operate on a relatively smaller scale in terms of number of shipments. Notably, there is limited representation in the higher shipment categories (50-75 to >100) for both sole and grower-cum exporters. Sole exporters display a marginal presence in the >100 category at 1.33%, while grower-cum exporters have 16% representation. These findings suggest that a high proportion of firms operate within the lower shipment categories.

To check if the grower-cum exporters are operating with high number of shipments, the non-significant two-sample t-test value revealed that on average, both sole and grower-cum exporters have relatively similar number of shipments. Sole exporters have a mean of 32.33 numbers of shipments, while grower-cum exporters exhibit a higher mean of 94.92. These findings underscore the operational similarity in terms of number of shipments between these two groups of exporters.

Table 3.7: Frequency distribution of exporting firms' shipments (nr./season)

Shipments categories	Exporter type		Total (%)
	Sole (%)	Grower-cum (%)	
(0-25)	57.33	52.00	56.00
(25-50)	24.00	24.00	24.00
(50-75)	10.67	0.00	8.00
(75-100)	6.67	8.00	7.00
>100	1.33	16.00	5.00
Mean of all groups	32.33	94.92	47.98
t-statistic			-1.22

Note: *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively.
Source: Author's calculations

Lastly, the frequency distribution of qualitative characteristics of the firms has been discussed. Table 3.8 shows a substantial difference in the distribution of mango exporting firms using HWT (treating mangoes at 45–48°C for 50–60 minutes) as a treatment type between sole and grower-cum exporters. A significant 84% of sole exporters use HWT, while only 48% of grower-cum exporters do the same. A noteworthy 52% of growers-cum exporters opt for HWD, in contrast to 12% of sole exporters. VHT is primarily favored by sole exporters, with 4% utilizing this treatment type, whereas grower-cum exporters do not use VHT significantly. The chi-square statistic for treatment type reveals a highly significant association ($\chi 2$ = 17.88***) between the type of treatment (HWT, HWD, and VHT) and the exporter type (sole, grower-cum).

For treatment plant facility, a significant proportion of grower-cum exporters, 56%, operate with their own treatment plant facilities, whereas only 9.33% of sole exporters have their own facilities. A substantial 90.67% of sole exporters opt for rented treatment plant facilities, compared to 44% of grower-cum exporters. The chi-square statistic for the treatment plant facility indicates a highly significant association ($\chi 2$ = 21.88 ***) between the treatment plant facilities (own or hired) and the exporter type (sole, grower-cum). This association highlights significant difference in the ownership and use of treatment plant facilities between the two exporter types.

For packhouse facilities, Table 3.8 shows that grower-cum exporters significantly favor owning packhouse facilities, with 96% of them having their own facilities, while only 9.33% of sole exporters own packhouse facilities. A considerable 90.67% of sole exporters opt for rented packhouse facilities, compared to just 4% of grower-cum exporters. The chi-square statistic for packhouse facility status reveals a significant association ($\chi 2$ = 3.25*) between the ownership of packhouse facilities (owned or rented) and the exporter type (sole, grower-cum). This association indicates disparities in the preference for owning packhouse facilities between the two exporter categories, with grower-cum exporters more likely to own them.

Table 3.8: Frequency distribution of exporting firms by treatment type, treatment plant, and packhouse facility

Treatment type categories	Exporter type		Total (%)	$\chi 2$ statistic
	Sole (%)	Grower-cum (%)		
Hot water treatment (HWT)	84.00	48.00	75.00	17.88 ***
Hot water dip (HWD)	12.00	52.00	22.00	
Vapor heat treatment (VHT)	4.00	0.00	3.00	
Treatment plant facility categories				
Own	9.33	56.00	21.00	21.88 ***
Hired	90.67	44.00	79.00	
Packhouse facility categories				
Own	9.33	96.00	82.00	3.25 *
Rented	90.67	4.00	18.00	

Note: *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively.
Source: Author's calculations

3.2.3 Export process and target markets

The export of mangoes from Pakistan is not merely a transaction; it is a carefully orchestrated process that unfolds through several distinctive stages. This section provides the intricacies of the mango export process in Pakistan. This export process is a multifaceted endeavor, shaped by various stages, each demanding careful attention to detail. Furthermore, the destination markets for this product have been examined. The mango export landscape encompasses a diverse array of markets, each with its unique requirements, preferences, and regulations.

Beginning with the procurement stage, where mangoes are sourced from various channels to the precise sorting, grading, treatment, and cooling processes, this section presents each phase with a brief focus on the variations in requirements for

EU and non-EU countries. From packing and obtaining essential certificates to the final stages of shipment and tracking, this subsection also demonstrates the meticulous procedures and regulations that ensure Pakistan's mangoes reach destinations with high quality and safety standards.

The export process of mango in Pakistan initiates with the procurement stage, where mango exporters source mangoes from various sources, which can include farmers, wholesale markets, or their own sources, i.e., grower-cum exporters. This initial stage involves assessing the quality and quantity of mangoes to meet the demanding export standards. Following the procurement stage, mangoes are transported to the packhouse for sorting and grading, a crucial step in ensuring that only high-quality mangoes are separated for export. Notably, all mango exporting firms in this study are actively involved in grading. Out of these firms, 75 prefer the manual grading process, while the remaining 25 employ the machine-based grading method. However, for exporting mangoes to non-EU countries, out of the 56 firms only 7 firms opt for manual grading, while the rest of the firms choose not to grade their mangoes at all.

The next critical stage is the treatment application at the treatment plant facility. Treatment is essential to meet stringent phytosanitary requirements and ensure that the mangoes are free from pests and diseases. There are three primary types of treatment applications: hot water dip (HWD), hot water treatment (HWT), and vapor heat treatment (VHT). The treatment application is a mandatory step for export to the EU, while the choice of treatment method varies among exporters. From the 100 sample firms, 75 firms prefer HWT, 22 firms opt for HWD, and only 3 firms utilize VHT. Conversely, treatment application is not obligatory for non-EU export markets, and mangoes can be exported without undergoing any treatment process. After the treatment process, mangoes go through the cooling stage, where they are subjected to open-air cooling or cold storage cooling, based on logistical considerations and the exporter's preferences.

The treatment verification stage is crucial for ensuring compliance with export regulations. Two private companies, authorized by the Government, Control Union and SGS[17], are responsible for verifying that the treatment is correctly applied. Once treatment verification is complete, mangoes proceed to the packing stage at the packhouse facility. Exporters have the option to use either local or imported boxes

[17] Control Union Pakistan (CUP) and SGS are companies that conduct inspections and issue certificates, confirming that the mangoes (or other export commodity) meet the required standards.

for packing, with the choice influenced by factors such as cost, quality, availability, and target markets' requirements. Before mangoes can be shipped, various clearance certificates from different departments like customs, plant protection, Anti-Narcotic Force (ANF), and verification agencies are required. These documents ensure that the mangoes adhere to all relevant regulations and are safe for export. Upon completing all the necessary documentation and packing, the mangoes are ready for shipment and can be transported either by air or sea, depending upon the destination and logistical considerations. In the context of this study, four distinct export markets based on the destination for Pakistan's mango export have been delineated. A description of these export markets is given in the following table.

Table 3.9: Description of four export target markets

Export markets	Nr. of firms	Description
Aggregate exports	100	The market model is designed for all firms.
Specialized–EU exports	44	This market model is designed for the firms exporting mangoes only to the EU countries.
Diversified–EU exports	56	This market is defined for EU exports of those companies who are exporting mango to both EU and non-EU markets at the same time.
Diversified–Non-EU exports	56	This market is defined for non-EU exports of those companies who are exporting mango to both EU and non-EU markets at the same time. *Results of this market are not covered in main part of the thesis. However, they are reported in the Appendix 6-Appendix 12.*

Source: Author's description

Distribution of Pakistan's mango export quantity to the above-introduced target markets is presented in Figure 3.3. Overall, Pakistan exports 7% of its total production of mangoes. Based on author's survey data of 2014, a total of 3,004 tons of mangoes were exported to the Specialized–EU market. With a significantly larger share, Pakistan exported 13,508 tons of mangoes to the Diversified–EU market. Pakistan's mangoes also make a substantial impact in the Diversified–Non-EU exports, with 17,289 tons. The aggregate exports serve as a collective sum for Pakistan's mango exports, with a total of 33,801 tons being shipped. These figures define the diversity and reach of Pakistan's mango export industry, with each market playing its distinct role.

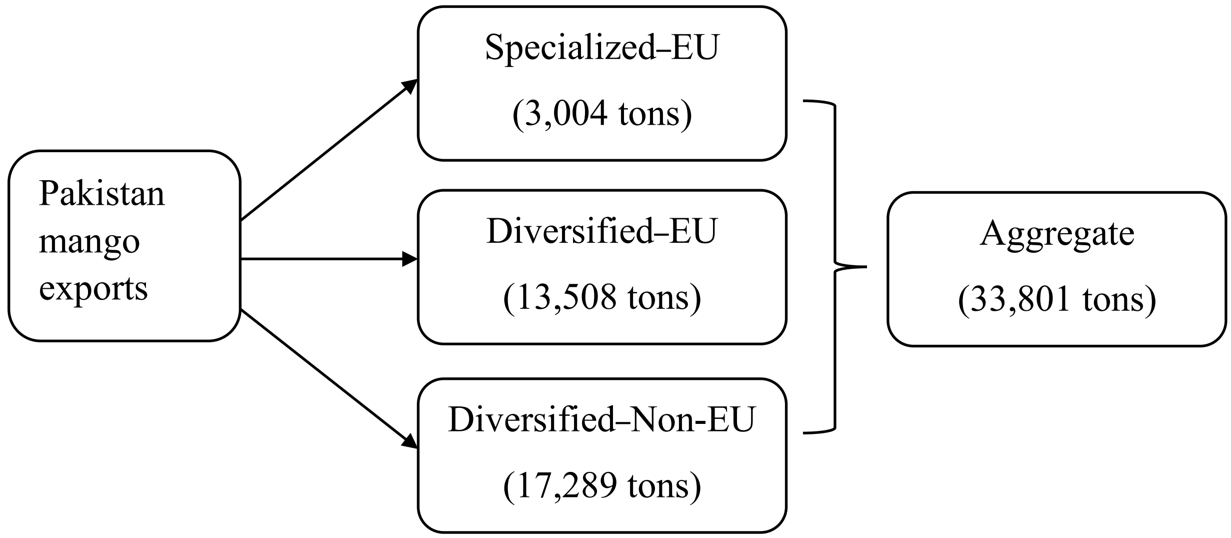

Figure 3.3: Pakistan's total mango export (ton) and its target markets (2014)

Source: Author's illustration based on survey data (2014)

3.2.4 Export supply and its transport mode distribution

In the exploration of export supply and its distribution, Figure 3.4 elaborates the firms' choice of transport modes, which includes air, sea, or a combination of both, presenting their preferences and adaptability. For exports to the EU, all firms primarily opted for air transport, highlighting the importance of safety when catering to the discerning EU, while among all these firms, 15 exhibit a unique approach by using both air and sea transport modes, indicating a dual strategy to meet varying demands within the EU market. Interestingly, the sole use of sea transport to the EU is absent, underscoring the time-sensitive nature of the mango export to this distant market.

A more diversified approach has been observed in exports to the non-EU market. While 52 firms choose air transport as their primary means, 14 firms opt for sea transport, reflecting flexibility in their logistics and possibly accommodating regions where air transport is less critical. Notably, 10 firms employ a mixed approach, using both air and sea transport. This choice might be driven by the need to meet the diverse requirements of non-EU exports, with considerations such as cost-effectiveness and delivery time playing pivotal roles.

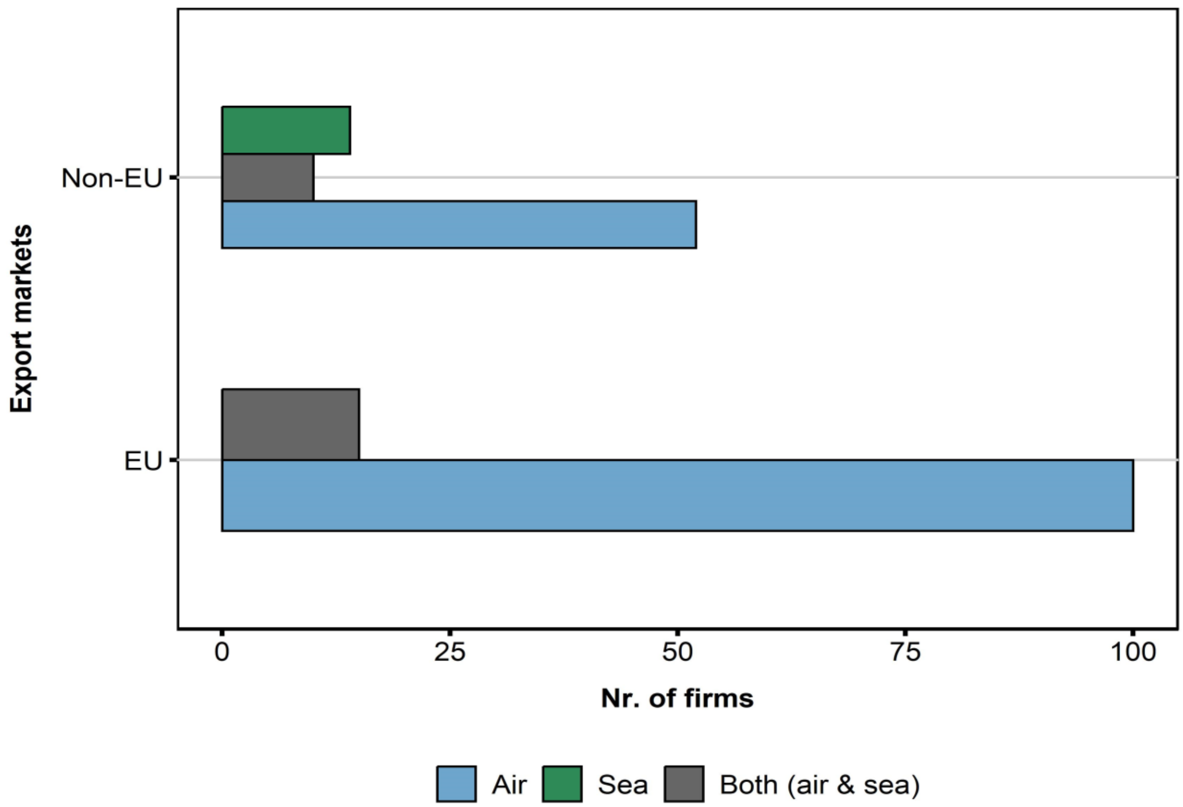

Figure 3.4: Pakistan's mango export by transport modes (2014)

Source: Author's illustration based on survey data (2014)

Following this comprehensive discussion of different transport modes, the mango export quantity dissecting the share of air and sea transport modes in EU and non-EU market is presented in Figure 3.5. For the EU market, a substantial percentage (59.1) of the total exports is shipped by air. This preference for air transport highlights the paramount role of speed and efficiency in satisfying the demands of the EU market. Conversely, the remaining 40.9% of the total mango export is exported through shipping companies. This indicates the considerable shipment size associated with sea transport, signifying a strategic approach that seeks to balance the need for cost-effectiveness with the demand for larger quantities. For mango exports to the non-EU market, a dichotomy is observed in the supply chain. Notably, 66.09% of the total mango export is done through shipping companies showing the dominance of sea shipments in this market, while the rest of the total exports are carried by air transport. Comparatively, in the non-EU market, a large percentage of its mango export supply is done via sea shipments, in contrast to the EU market.

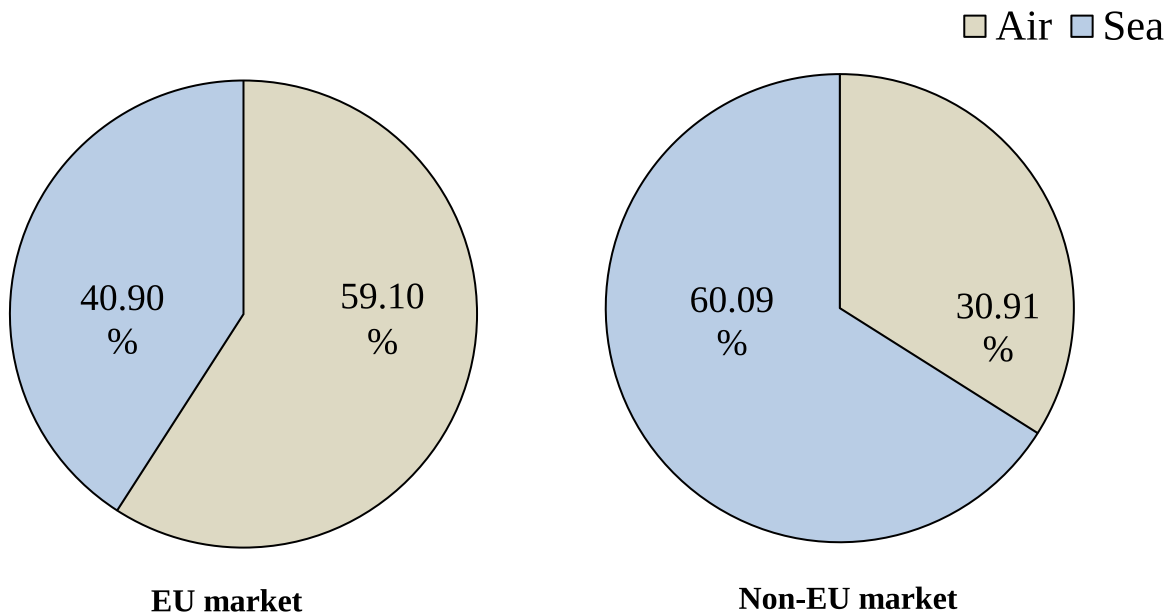

Figure 3.5: Pakistan's mango export quantity (%) by transport modes (2014)

Source: Author's illustration based on survey data (2014)

3.3 Pakistan mango in EU market and its major competitors

Among the various markets for mango exports, the EU stands out as a significant destination for mango-exporting countries. Pakistan holds a noteworthy position among these major exporters to the EU. Pakistani mangoes are globally renowned for their exceptional sweetness, juiciness, nutritional value, and distinct flavor. As documented by ZAHID & SHARIF (2023), Pakistan's mango exports amounted to 82.7 thousand metric tons, generating revenue of USD 82.7 million during the 2016-17 season. This marked a substantial growth compared to 2001-2002 when the export volume was 52.5 thousand metric tons and revenue amounted to USD 16.6 million, reflecting a remarkable 58% increase in quantity. However, it is imperative to highlight the growing discrepancy between mango production and exports in Pakistan, indicating a shift in the export-production ratio over time (SHAMOON & MUBARIK, 2020). This section elaborates EU's import demand pattern with extra-EU[18] as well as intra-EU[19] countries (Figure 3.6).

[18] The partner country is the non-EU country of origin of the goods, as defined under union customs legislation (EUROSTAT, 2023).

[19] The partner country is the EU member state, from which the goods are dispatched to another member state for the arrival of the goods according to the trade contract (EUROSTAT, 2023).

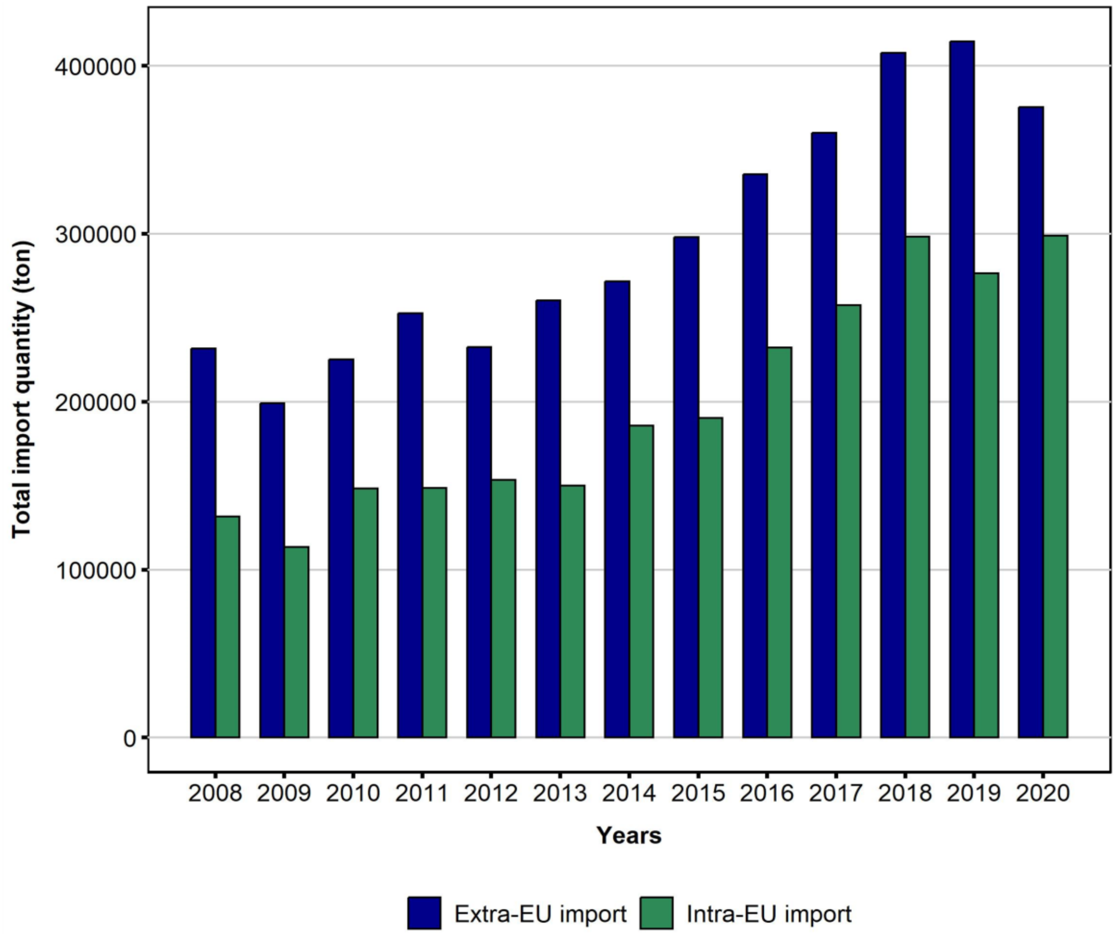

Figure 3.6: EU import quantity (ton) for thirteen years (2008-2020)

Source: Author's illustration based on EUROSTAT (2020)

In the total mango imports of EU, extra-EU countries accounted for 88% share (352,000 tons) in 2021 (BUSINESS, 2021). For Extra-EU imports of mangoes, there was a stagnant pattern of mango imports from 2008 to 2012. However, there was a consistent increase in extra-EU imports from 2012 to 2019. This growth indicates a rising demand for mangoes from non-EU countries, potentially driven by changing consumer preferences and market dynamics. It's worth noting that in 2020, there was a slight dip in extra-EU imports to 375,291 tons, which could be attributed to the disruptions caused by the COVID-19 pandemic, affecting international trade.

In contrast, the intra-EU mango imports depict a distinct pattern. Throughout the entire period, there is a consistent and upward trend in the quantity of mangoes imported. Starting at 131,608 tons in 2008, Intra-EU imports grew steadily, reaching 298,957 tons in 2020. This consistent growth indicates a rising demand for mangoes within the EU member states. It suggests that EU countries are increasingly sourcing mangoes from other EU member states, potentially driven by efforts to promote trade within the EU. Comparatively, it is evident that intra-EU imports remain at a lower magnitude than extra-EU imports throughout the years. Extra-EU imports are typically much higher in volume, highlighting the EU's significant reliance on non-EU exporters to meet their mango demand.

To explore the mango trade within the EU, the import and export dynamics of top EU member states have been discussed (see Table 3.10). It presents the top five EU countries involved in mango trade, their sourcing patterns, export contributions, and re-exporting within the EU market. The Netherlands leads the market with the highest quantity of mango imports from non-EU countries, making up a staggering 93% of its total mango imports. While the Netherlands imports 7% of its total import from EU member states. An impressive 73% of the total mango imported by the Netherlands is re-exported, underlining its pivotal role in re-exporting within the EU. Spain imports 86% of its total mango imports from the extra-EU countries and 14% from intra-EU countries. This emphasizes Spain's significant reliance on extra-EU sources. Spain re-exports a considerable share of 63% of the mangoes it imports, reflecting a substantial role in mango re-exporting within the EU market. Meanwhile, Germany accounts for 11% of its total mango imports from extra-EU sources, while 89% from intra-EU countries. This high share underscores Germany's role as a key buyer of mangoes within the EU market. A notable 18% of the mangoes imported by Germany are re-exported to other member states.

Table 3.10: Mango trade in the top five EU countries (2020)

Countries	Import (1000 ton)			Export (1000 ton)			Re-export quantity (%)
	Extra-EU	Intra-EU	Total	Extra-EU	Intra-EU	Total	
Netherlands	123.62 (93)	8.58 (7)	132.2	9.81 (10)	86.54 (90)	96.4	73
Spain	19.14 (86)	3.21 (14)	22.36	0.87 (6)	13.28 (94)	14.2	63
Germany	5.59 (11)	44.83 (89)	50.43	0.73 (8)	8.21 (92)	8.93	18
France	11.78 (33)	24.28 (67)	36.06	0.82 (9)	8.47 (91)	9.28	26
Belgium	15.85 (75)	5.23 (25)	21.08	0.47 (3)	15.07 (97)	15.5	74

Note: Values given in parenthesis are percentages.
Source: EUROSTAT (2020)

Overall, the Netherlands stands out a major player in the EU mango trade, with a significant share in imports and re-exports. Spain demonstrates a strong connection with non-EU countries, while Germany excels in importing mangoes within the EU. France and Belgium display different facets, with France heavily reliant on intra-EU imports and Belgium playing a pivotal role in mango redistribution within the EU.

To explore the mango trade within the EU market, its flow chart is presented in Figure 3.7. The Netherlands emerges as a pivotal importer, channeling a substantial portion of mangoes into the EU market. Notably, it also re-exports a significant share of its imported mango quantity to the neighboring countries; Germany, France, and Belgium. The remainder of the imported mangoes is redistributed to various other EU countries, in smaller quantities though. This strategic re-export underscores the Netherlands' central role in ensuring mango availability within the EU. Moreover, the Netherlands extends its mango exports to the UK also. France, another key player in this trade network, predominantly sources mangoes from Spain. This symbiotic relationship of mango trading shows the interdependence among EU member states.

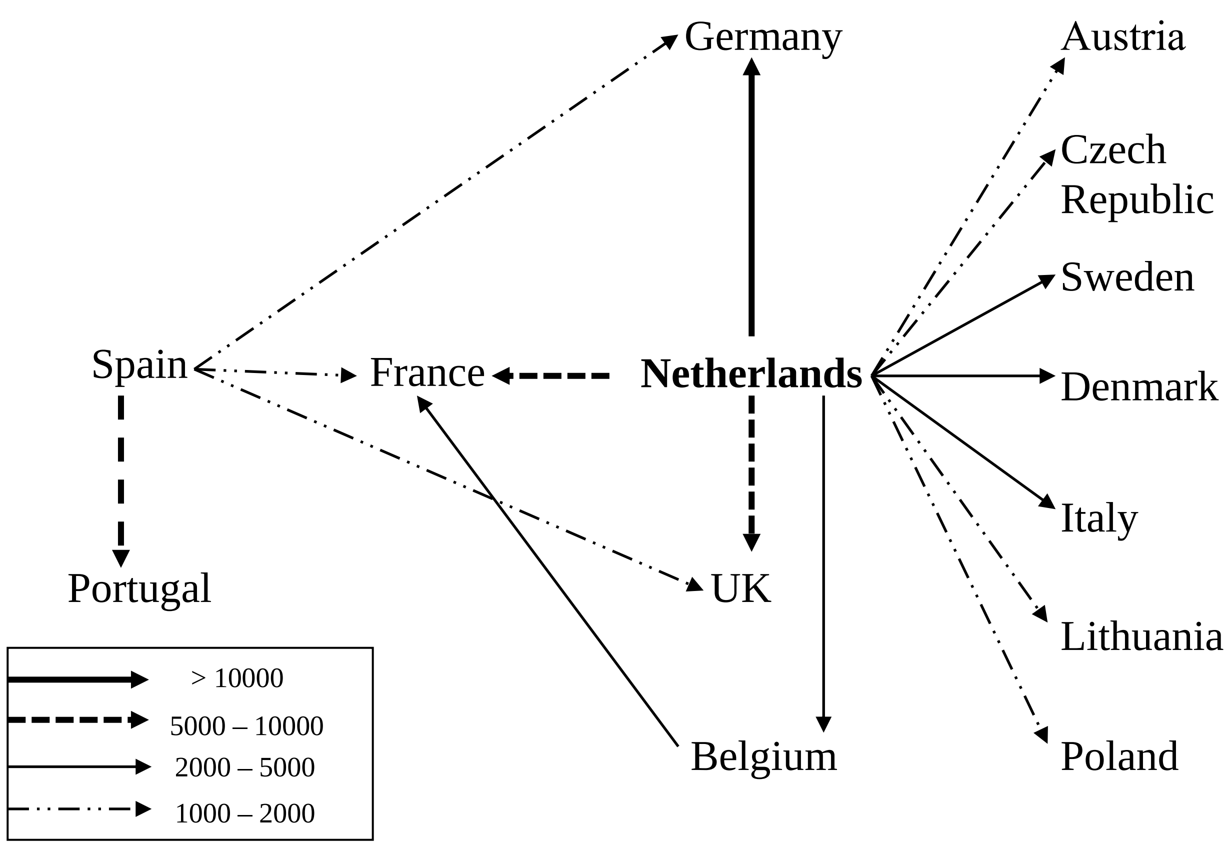

Figure 3.7: Mango trade flow (ton) within the EU market (2020)

Source: EUROSTAT (2020)

4 EXPORT EFFICIENCY ANALYSIS

The purpose of this chapter is to explore the socio-economic variables responsible for the technical efficiency of Pakistan mango exports to different markets. A non-parametric approach for the estimation of the technical efficiency of mango exporting firms is employed. The export performance of Pakistan's mango exporting firms has been evaluated by a comprehensive analysis of the technical efficiency scores of the firms, using two-stage data envelopment analysis (DEA). Subsequently, to identify the key factors affecting efficiency scores, censored regression models i.e., tobit and truncated regression have been employed. Hence, the main objective of this chapter is to provide empirical information regarding the efficiency enhancement of Pakistan mango exports, a vital component of the country's export sector.

4.1 Introduction

Pakistan, with its favorable climate and fertile land, has a rich history in fruit cultivation and has emerged as a significant exporter in the global fruit market. The export of fresh fruits holds immense importance for Pakistan's economy. It not only generates valuable foreign exchange earnings but also contributes to employment generation, rural development, and overall economic growth. However, the mango industry in Pakistan faces challenges as it is not fully developed. Issues such as underdeveloped production, harvesting, and marketing systems, along with an uneven distribution of returns, hinder its growth (HAQ et al., 2017). Additionally, traditional harvesting, poor packing, the absence of modern cold storage, lack of treatment & grading plant facilities, and inadequate transportation means further impede the flourishing of the mango export supply chain. Growers also often neglect proper care of their mango crops and sell the fruit to contractors (TRTA, 2010).

Apart from these challenges, various farm-level issues contribute to the low yield of mangoes in the country. Several studies have identified factors responsible for the yield gap in Pakistan's mango production. Infected mango trees and poor management practices, including pest diseases, are known to cause significant problems (SAEED et al., 2012). According to MOHSIN et al., (2014), inadequate management practices, such as improper use of pesticides, irrigation, and fertilizer, exacerbates these issues. While many studies have covered firm related issues, there is still a recognized gap in accessing the efficiency level of mango exporting firms.

To enhance the export performance, it is crucial to understand the factors that influence the technical efficiency of mango exporting firms. By identifying the determinants of export efficiency, targeted interventions and policies to enhance the competitiveness of Pakistan mango exporters can be formulated. With its understanding, industry practitioners can improve supply chain management and optimize their resource allocation. Additionally, individual firms can identify specific areas for improvement and develop strategic initiatives to enhance their export performance, ultimately boosting their profitability and contributing to the growth of the sector.

Therefore, this chapter aims to evaluate the export performance of Pakistan's mango exporting firms by conducting an efficiency analysis with a two-stage data envelopment analysis (DEA) method. In the first stage, efficiency scores have been computed at the firm level. To evaluate the impact of various determinants on these computed efficiencies, tobit, and truncated regression models have been employed in the second stage of the analysis.

4.2 Analytical framework

4.2.1 Measuring technical efficiency

Based on the work of DEBREU (1951) and KOOPMANS (1951), the concept of technical efficiency was initially introduced by FARRELL (1957). In his study, FARRELL distinguished between two forms of efficiency: technical efficiency and allocative efficiency. Technical efficiency (TE) assesses a firm's capacity to achieve the maximum output given a specific set of inputs. On the other hand, allocative efficiency evaluates the ability to employ the optimal combination of inputs based on prevailing prices and production techniques, often referred to as price efficiency. In the context of the analysis presented in this chapter, the focus has been on estimating technical efficiency, also referred to as export efficiency.

FARRELL (1957) illustrated the above-mentioned concepts through the example of a firm with a production process involving two inputs (X_1, X_2) and one output (q), under the assumption of constant returns to scale (CRS). The CRS assumption states that a uniform and proportional increase in all inputs, over the long term, will lead to an increase in output in the same proportion. However, this assumption is suitable only when all decision-making units (DMUs) are operating at an optimal scale, resulting in TE being influenced by scale efficiencies[20] (SE). In response to this,

[20] In DEA, scale efficiency assesses whether a firm is operating at its optimal size. A unit is assumed to be scale efficient when its scale of operations is considered optimal.

BANKER, CHARNES & COOPER (1984) proposed an extension of the CRS DEA model to accommodate variable returns to scale (VRS) situations. The use of the VRS specification allows for the calculation of TE without these SE effects.

The input-oriented model assesses the disparity between the actual production point (P) and the fully efficient production point (Q), where Q lies on the isoquant SS'. In the context of this study, TE is quantified using the ratio: $TE = 0Q/0P$. The resulting TE values range between zero and one, reflecting the efficiency of the firm's production process. The distance QP represents technical inefficiencies, indicating that inputs can be reduced without altering the outputs. A TE score of unity is achieved when P can be moved to Q on the isoquant, signifying that the firm is technically efficient. In such a case, the TE score equals one, indicating the optimal use of inputs to achieve the given level of output.

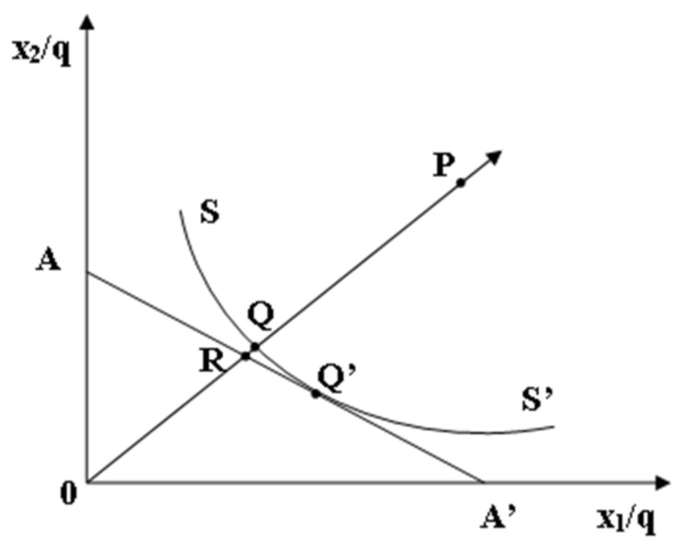

Figure 4.1: Technical and allocative efficiencies

Source: COELLI et al., (2005)

The analysis discussed above demonstrates FARRELL (1957) input-oriented measure, which assesses a firm's capability to reduce inputs without altering outputs. An alternative approach, known as the output-oriented measure, evaluates the ability of a firm to increase output without changing inputs. In practical terms, the selection between input-oriented and output-oriented measures depends on the specific objective. If the goal is to minimize inputs while maintaining outputs, the input-oriented measure is employed. Conversely, if the aim is to maximize output without changing inputs, the output-oriented measure is utilized. The choice between these measures is contingent on whether the primary focus is on input minimization or output maximization while keeping other elements constant (FAO, 2003). In this study, VRS input-oriented model has been used to determine how exporters can gain efficiency by minimizing their inputs (cost).

4.2.2 Data envelopment analysis (DEA)

Data Envelopment Analysis (DEA) is a widely recognized method for assessing efficiency among decision-making units (DMUs). It was introduced by CHARNES et al., (1978) in their CCR model study. This model allowed them to convert the fractional linear measure of efficiency into a linear programming model (ALDAMAK & ZOLFAGHARI, 2017). DEA has since attracted the attention of many researchers as this robust approach can handle models with multiple inputs and outputs to calculate technical efficiency, without needing to know if the output follows a linear, quadratic, or exponential function of inputs (REZITIS & KALANTZI, 2016). Moreover, DEA is flexible in dealing with different units of inputs and outputs, making it applicable in industries with diverse measurement scales.

Efficiency measurement and performance optimization can be achieved through the application of either non-parametric methods, like DEA, or parametric methods, such as stochastic frontier analysis (SFA). Non-parametric frontier measures, like DEA, have an advantage over parametric approaches that they place less structure on the shape of the efficient frontier (KHOSHROO et al., 2013). DEA is described as a formulation of a non-parametric piece-wise surface (or frontier) over the data (COELLI et al., 2005). In DEA, the input-oriented variable returns to scale (VRS) model can be formulated as,

$$min_{\theta,\lambda}\theta \tag{4.1}$$

This model is input-oriented and allows for variable returns to scale, meaning that it accommodates situations where a firm's efficiency may change with different scales of production. In this model, θ represents the total technical efficiency score of the i^{th} firm and λ is a Nx1 vector of constants associated with the weights assigned to each input and output of the firm. The value of θ is subject to the restriction $0 \leq \theta \leq 1$. If $\theta = 1$, it indicates that the firm is technically efficient. On the other hand, when $\theta < 1$, it implies that the firm is becoming less efficient. Hence, the VRS DEA model is subject to the following constraints summarized from COELLI et al., (2005),

$$-q_i + Q\lambda \geq 0, \tag{4.2}$$

$$\theta x_i - X\lambda \geq 0, \tag{4.3}$$

$$N_1'\lambda = 1, \tag{4.4}$$

$$\lambda \geq 0 \tag{4.5}$$

In the VRS DEA model, a convexity constraint ($N_1'\lambda = 1$) ensures that an inefficient firm is only compared to or benchmarked against firms of a similar size. The use of $N_1'\lambda = 1$ signifies a strict equality.

4.2.3 Determinants of technical efficiency

Examining the factors that potentially influence technical efficiency holds significant importance as it is essential for designing strategies and plans aimed at enhancing the organizational performance and competitiveness of a sector (REZITIS & KALANTZI, 2016). In the existing literature, many studies have adopted a two-stage approach to measure efficiency. In the first stage, the DEA method is employed to calculate technical efficiency. Subsequently, the efficiency scores obtained from DEA estimations are utilized as dependent variables in a second-stage regression analysis, where they are regressed against exogenous variables as potential determinants. This second stage often involves tobit or OLS regression (TUNG, 2013).

As an alternative to OLS regression, SIMAR & WILSON (2007) proposed the use of truncated regression based on comparative analysis. This truncated regression serving as a substitute for OLS regression in the second stage of the analysis, deals with censoring of observations, specifically right-censoring. OGUNDARI & BRÜMMER (2011) also demonstrated that both tobit and truncated regression models outperform the OLS approach.

In this chapter, above discussed two-stage approach is implemented to examine technical efficiency and its determinants for Pakistani mango exporting firms. This DEA based analysis contributes to the empirical understanding of Pakistan mango export economics. Initially, export efficiency scores for the firms are calculated by using the DEA approach. Subsequently, tobit regression and bootstrapped truncated regression estimations are employed, aiming to explore the factors influencing the export efficiency obtained from the DEA.

Tobit and truncated regression models are forms of non-linear regression that involve information loss, impacting both the dependent and independent variables (ARAMYAN, 2007). Since export efficiency exceeding 1 is not possible, it has led to the imposition of strict upper thresholds set at 1 in this chapter. The estimation method employed for these models is maximum likelihood estimation. Lastly, bootstrap method in truncated regression is applied where the resampling has been carried out for 1000 replications i.e., B=1000.

4.2.4 Model specification

With the estimated technical efficiency (θ_i) of the i^{th} firm, obtained from DEA input oriented-VRS model of each mango exporting firm, the general form of the censored regression models (i.e., tobit and truncated regressions) for the identification of the j^{th} determinants impacting the efficiency of firms, is expressed as follows:

$$\theta_i = \alpha + \beta\Omega_{ij} + \epsilon_i \tag{4.6}$$

In the model presented in equation (4.6), α is the constant term, Ω_{ij} (i = 1, 2, …, 100; *j*= 1, 2, …, 21) is a matrix of specific determinants that may influence the technical efficiency of the firms, and ϵ_i is the error term.

4.3 Variables description

The research design for this section is based on the cross-sectional nature of the dataset. By using a survey questionnaire, a total of 100 mango exporting firms were interviewed. Based on their target markets and export strategies, these firms have been categorized into four distinct export market models to analyze the export efficiency and profitability for each market, separately. However, the first three markets are discussed in this chapter while the results for the last market i.e., Diversified–non-EU market are reported in Appendix 6-Appendix 9. The description of these export markets has already been discussed in Table 3.9.

Technical efficiency analysis of these export models aims to explore the intricate factors influencing the export efficiency of firms in their respective markets, contributing to an extensive understanding of the dynamics within Pakistan's mango export industry.

The first stage in the efficiency analysis of exporting firms includes the calculation of the efficiency score of each firm for its export market through DEA. Table 4.1 provides the input and output variables used in first stage of DEA. For each market, the output variable is the total mango export quantity with respect to that market. Input variables have been included based on their potential impact on firms' efficiency. The computed efficiency from the above-defined input-output variables set will show each firm's business performance.

Table 4.1: Description of variables used in efficiency scores calculation

Variables	Description
Output variable	
Total mango export (ton/season)	The overall quantity of mangoes exported during a specific season per market model.
Input variables	
Initial mango supply (ton/season)	The quantity of mangoes a firm has at its disposal at the beginning of the season.
Firm capital (million rupees)	The financial net worth of all the resources invested in the business by the exporting firm.
Packhouse capacity (ton/day)	The facility where mangoes are stored, sorted, graded, and processed for packaging.
Permanent employees (nr.)	The count of full-time workers employed by the exporting firm.
Seasonal employees (nr.)	The number of temporary workers hired by the firm during peak season or periods of high demand.
Total employees (nr.)	*The sum of permanent and seasonal employees, indicating the overall size of the firm's workforce.*

Note: Input variable, *total employees,* is used in efficiency score calculation of Diversified–non-EU market only.
Source: Author's description

In the second stage of the DEA, the efficiency score for all firms under each market model will be employed as response variable in censored regressions i.e., tobit and truncated, against its determinants. The number of determinants used in regression depends upon the export market. It will help in providing valuable information about the different factors influencing the export performance of mango exporting firms in Pakistan.

A set of determinants representing the exporter's socio-economic characteristics and activities of exporting firms has been introduced as a function of efficiency scores of firms. The purpose of inclusion of these determinants is to capture the share of each factor in efficiency of firms obtained in first stage of data envelopment analysis. Hence, the list of determinants, used in tobit and truncated regressions under each market, along with their descriptions is presented in Table 4.2.

Table 4.2: Description of variables used in regression analysis

Variables	Description
Age (year)	The age of the owner of exporting firm.
Education (year)	The nr. of years of education obtained by the firm's owner.
Experience (year)	The time period since the exporter is doing the business.
Exporter type	It classifies the firm based on its type of export operation; sole exporter (1) and grower-cum exporter (2).
Exporter category	It categorizes the firm based on its organizational structure; Independent exporter (1) and group exporter (2).
GAP certification	It indicates whether the exporting firm has obtained good agricultural practices (GAP) certification, with categories; yes (1), no (2), and mixed (3).
Procurement timing	It classifies firms on the timing strategy employed for acquiring or producing mangoes, with early (1), mid (2), late (3), and mixed (4).
Participation in trade exhibitions (nr./year)	The number of trade exhibitions in which the exporter has actively participated within a year.
Packing boxes	Type of packing boxes used by the firm for packaging mangoes; local (1), imported (2), and mixed (3).
Varieties exporting (nr.)	The number of different mango varieties exported by the firm.
Packhouse to the departure port distance (km)	The distance between the firm's packhouse facility and the departure port (air, sea or both), from where mangoes are shipped.
Packhouse facility	It identifies whether the firm owns or rents-in the pack house facility as; own (1) and on rent (2).
Average volume per shipment (ton)	It represents the average quantity of mangoes shipped by the firm in a single shipment.
Treatment type	*The method of treatment applied to mango; hot water treatment- HWT (1), hot water dip- HWD (2), and vapor heat treatment- VHT (3).*
Treatment plant facility	*It indicates whether the treatment plant facility used is owned (1) or hired (2) by the exporting firm.*

Note: Variables in *Italics* are used in regression analysis of Specialized–EU and Diversified–EU exports only. Values in parenthesis show the encoding of categories for the respective variable.
Source: Author's description

Descriptive statistics of the variables used in the regression analysis of efficiency are reported in Table 4.3. Total mango exports vary widely, ranging from 4.2 to 8824.2 tons per season, with an average of 338 tons. Firms' initial mango supply ranges from 4.5 to 9500 tons/season, averaging 369.6 tons. Investment in firm capital has an average of 75.35 million rupees, and pack house capacity exhibits an average of 91.34 tons with significant diversity, ranging from 3 to 2500 tons/day. Workforce-related metrics vary widely with total number of employees ranging from 4 to 1105. Exporters' educational levels fluctuate between 0 (no education) and 16 years. Work experience of exporter ranges from 1 to 50 years, averaging almost 14 years. In terms of attending trade-related events, participation in trade exhibitions varies from 0 to 5 times per year, with an average of 1.07 times. Firms export between 1 and 8 mango varieties, with an average of almost 3 varieties.

Table 4.3: Summary statistics of scale variables used in regression analysis

Variables	Min	Max	Mean	St. dev
Total mango export (ton/season)	4.20	8824.20	338.00	1081.40
Initial mango supply (ton/season)	4.50	9500.00	369.60	1168.70
Firm capital (million rupees)	0.20	920.00	75.35	167.27
Packhouse capacity (ton/day)	3.00	2500.00	91.34	273.21
Permanent employees (nr.)	1.00	300.00	18.74	34.05
Seasonal employees (nr.)	0.00	800.00	47.25	82.88
Total employees (nr.)	4.00	1105.00	66.58	144.20
Age (years)	23.00	75.00	46.75	11.91
Education (years)	0.00	16.00	10.42	3.93
Experience (years)	1.00	50.00	14.02	10.92
Participation in exhibitions (nr./year)	0.00	5.00.00	1.07	1.28
Varieties exporting (nr.)	1.00	8.00.00	3.05	1.50
Packhouse to dep. port distance (km)	6.00	800.00	93.79	159.50
Average volume per shipment (ton)	1.52	16.30	4.279	3.65

Source: Author's calculation

Categorical variables to be used in censored regressions provide information about various characteristics and practices of the exporting firms. Table 4.4 presents the general overview of categorical determinants along with frequency for each category. Most of the exporters in the study sample are found to be independent exporters, with 75 occurrences. Many of these exporters do not have GAP certification, and only a few perform mixed practices. For procurement timing, most firms use a mixed approach, while a smaller group prefers early timing.

A majority of the firms use local packing boxes, while a smaller number choose imported ones. Notably, most of the firms have their own pack house facilities. It is also observed that hot water treatment is the common fruit treatment method, with 75 out of 100 firms adopting it as their preferred treatment type. Finally, for treatment plant facility, most of the firms are using a hired facility, occurring 79 times, while a few have their treatment plant facility, with a frequency of 21 occurrences.

Table 4.4: Summary statistics of categorical variables used in regression analysis

Variables	Nr. of categories	Category (frequency)
Exporter type	2	1. Sole exporter (75), 2. Grower-cum exporter (25)
Exporter category	2	1. Independent exporter (71), 2. Group exporter (29)
GAP certification	3	1. Yes (33), 2. No (47), 3. Mixed[21] (20)
Procurement timing	4	1. Early (16), 2. Mid (4), 3. Late (3), 4. Mixed (77)
Packing boxes	3	1. Local (65), 2. Imported (18), 3. Mixed (17)
Packhouse facility	2	1. Own (82), 2. On-rent (18)
Treatment plant facility	2	1. Own (21), 2. Hired (79)
Treatment type	3	1. HWT (75), 2. HWD (22), 3. VHT (3)

Note: Values in parenthesis are frequencies
Source: Author's calculation

4.4 Results and discussion

4.4.1 Technical efficiency of Aggregate exports

At the first stage of the analysis, the efficiency scores for 100 firms exporting to the aggregate market are estimated by using the DEA method. Table 4.5 presents the frequency distribution of efficiency scores obtained for 100 firms. Most of these firms, encompassing 80%, exhibit a high level of technical efficiency, falling within the efficiency range of 0.9 to 1.

[21] Mixed certification means mango procured from both certified and non-certified acreage of the orchard.

Table 4.5: Frequency distribution of firms' efficiency scores for Aggregate exports

Efficiency level	Frequency	Percentage
<0.80	0.00	0.00
0.80-0.90	20.0	20.0
0.90-1.00	80.0	80.0
Nr. of obs.		100
Minimum		0.81
Maximum		1.00
Mean		0.97
St. deviation		0.03

Source: Author's calculation

However, efficiency scores falling in the 0.8 to 0.9 range indicate that there could be some inefficiencies or areas where these 20% firms can further optimize their input utilization to enhance overall export efficiency. Importantly, none of these firms recorded an efficiency level below 0.8, underscoring an absence of significantly underperforming entities. The mean efficiency score of 0.97 indicates a high average level of technical efficiency across the firms with a low SD of 0.03, suggesting a consistent performance among the companies in terms of technical efficiency.

Before the estimation of regression models, a subset of categorical determinants has been selected to be treated as dummy variables based on their importance with respect to the efficiency. This has been achieved by observing the distribution of efficiency scores across different levels of categorical determinants. Figure 4.2 illustrates that the efficiency across exporter type, exporter category, and packing boxes determinants do not differ.

Based on this plot and the frequencies of each category, important categories w.r.t the efficiency score from each categorical determinant have been selected to treat them as dummy variables in the regression models. The selected categorical variables along with the scale variables are presented in the estimated regression results (see Table 4.6). It is important to mention that for any dummy variable i.e., procurement timing-early, early is encoded as 1 and the absence of other categories (mid, late, and mixed) is encoded as 0.

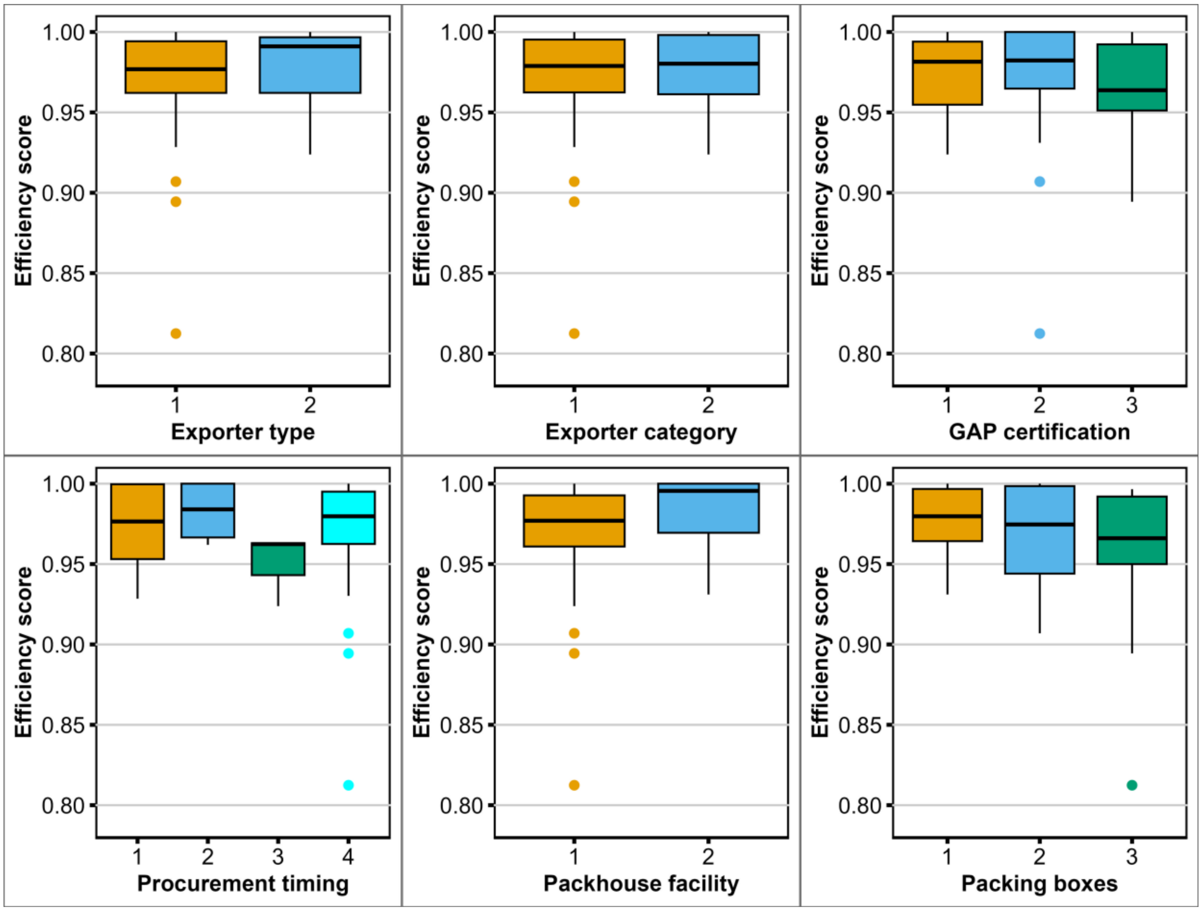

Figure 4.2: Distribution of firms' efficiency scores for categorical variables in Aggregate exports

Source: Author's illustration based on survey data (2014)

a) <u>Tobit regression</u>

The estimated results of tobit regression for aggregate exports provide an idea about the factors affecting the efficiency of exporting firms. Due to censoring of the efficiency scores, 17 out of 100 firms are found to be censored in terms of their efficiency. Results obtained from this regression for the censored export efficiency are presented in Table 4.6. The Wald statistic is found 32.4 (p-value<0.001), suggesting that collectively, the set of explanatory variables included in the model is statistically significant in explaining the variation in efficiency scores.

Firstly, the impact of exporters' socio-economic characteristics on exports is discussed. It is observed that age and education exhibit significant relationships with the export efficiency while the experience is accounted for non-significant effect. The coefficient of age depicts its inverse relationship with efficiency of firms in this market. It suggests that firms run by older exporters may need to adopt more innovative practices to maintain or improve the efficiency of firms in mango exports. The study by SHAFIQ & REHMAN (2000) also elaborated this contradictory finding regarding the impact of exporters' age on efficiency as younger exporters tend to be more inclined towards innovation and place a greater emphasis on marketing efforts.

The education of the exporters demonstrates a positive coefficient, inferring that higher education levels of exporters positively influence the firms’ efficiency. AHMAD et al., (2018) in their study of export determinants of citrus fruits in Pakistan, reported that education not only helps to identify and capitalize the potential markets but also serves as a crucial variable in applying the knowledge and skills related to various export activities. Although non-significant but positive coefficient of experience aligns with the economic theory. It is always considered valuable for gaining in-depth knowledge about the intricacies, prospects, and challenges specific to the industry. AHMAD et al., (2018) highlighted that as stakeholders accumulate more experience over time, there is a potential for a reduction in per unit costs, thereby increasing productivity. This heightened productivity can enhance competitiveness in the international market.

Table 4.6: Factors associated with technical efficiency of firms in Aggregate exports (tobit regression)

Variables	Estimate	Std. error	z value	Pr.(>|z|)
Intercept	-0.011	0.017	-0.668	0.50
Age (year)	-0.0003	0.0001	-2.062	0.03**
Education (year)	0.001	0.001	1.920	0.05*
Experience (year)	0.0002	0.0002	0.354	0.72
Exporter type-sole	-0.009	0.007	-1.213	0.22
Exporter category-independent	-0.003	0.005	-0.718	0.47
GAP certification-no	0.001	0.004	0.289	0.77
Procurement timing-early	-0.0004	0.008	-0.052	0.95
Procurement timing-mixed	0.003	0.008	0.411	0.68
Participation in exhibitions (nr./year)	-0.001	0.002	-0.372	0.71
Packing boxes-local	0.014	0.005	3.050	0.00***
Varieties exporting (nr.)	0.004	0.001	2.69	0.00***
Packhouse to dep. port distance (km)	0.001	0.002	0.248	0.80
Packhouse facility-own	-0.012	0.005	-2.225	0.02**
Average volume per shipment (ton)	-0.003	0.004	-0.839	0.40
Log (scale)	-4.138	0.08	-51.89	0.00***

Note: *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively.

Source: Author’s estimations

For dummy variables representing the characteristics of firms and export process, the use of local packing boxes, varieties of mango exporting, and owning a packhouse facility indicates significant relation with export efficiency, while the rest of the variables are found to have non-significant impact. The packing boxes-local stands out with a positive coefficient showing that firms using local packing boxes tend to have significantly higher efficiency scores. These firms are likely to benefit from cost-effective and tailored packaging solutions. The number of varieties exported also exhibits positive effect, indicating that firms exporting a greater variety of mangoes tend to have higher export efficiency. This positive correlation was also implied by AGYEI-SASU & EGYIR (2010) in their study of tobit regression to estimate export success in horticulture products of Ghana.

On the other hand, packhouse facility-own displays a negative coefficient, indicating that firms with their own pack house facilities display lower efficiency scores, suggesting that these firms may need to reconsider their business operations to boost efficiency. Notably, the coefficient of GAP certification-no is found non-significant in this model. There are some studies which suggest that certification does not lead to the economic upgrading of export process in developing countries (CRAMER et al., 2017; AKRONG et al., 2022).

b) Truncated regression

The estimates obtained from truncated regression for firms' export efficiency are presented in Table 4.7. Concerning variables associated with the characteristics of the firms' owners, it is observed that age and education impact significantly on the export efficiency of firms while experience does not have a significant impact. Age with negative coefficient suggests that older exporters may experience challenges in maintaining high levels of efficiency and positive coefficient for education infers that higher education levels among exporters positively influence efficiency achieved by the firm.

For instance, AGYEI-SASU & EGYIR (2010) also supported the positive relationship between education of the owner and export success of the firm as it helps to adopt new technology and bring in new ideas for the improvement of the firm's performance. The negative and non-significant relationship between experience and technical efficiency aligns with the findings of ALVAREZ & CRESPI (2003) in their study, determinants of efficiency in small firms.

Table 4.7: Factors associated with technical efficiency of firms in Aggregate exports (truncated regression)

Variables	Estimate	Std. error	z value	Pr.(>|z|)
Intercept	0.99	0.013	76.856	0.00***
Age (year)	-0.0002	0.0001	-1.906	0.05*
Education (year)	0.001	0.0004	2.053	0.04**
Experience (year)	-0.0003	0.0002	0.498	0.61
Exporter type-sole	-0.008	0.005	-1.391	0.16
Exporter category-independent	-0.003	0.004	-0.791	0.42
GAP certification-no	-0.001	0.004	-0.397	0.69
Procurement timing-early	-0.002	0.006	-0.256	0.79
Procurement timing-mixed	0.003	0.006	0.501	0.61
Participation in exhibitions (nr./year)	-0.001	0.001	-0.54	0.58
Packing boxes-local	0.01	0.004	2.666	0.00***
Varieties exporting (nr.)	0.003	0.001	3.03	0.00***
Packhouse to dep. port distance (km)	-0.0005	0.002	0.241	0.81
Packhouse facility-own	-0.009	0.004	-2.096	0.03**
Average volume per shipment (ton)	-0.005	0.003	-1.663	0.09*
Sigma	0.013	0.001	14.143	0.00***

Note: *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively.
Source: Author's estimations

For variables related to firms' characteristics and mango export process, packing boxes, varieties exporting, owning a packhouse facility and average volume per shipment are found to be significantly influencing the export efficiency. The packing boxes-local demonstrates a positive coefficient, indicating that firms using local packing boxes tend to have significantly higher efficiency scores. The number of varieties exported also displays a positive coefficient, inferring that diversifying mango varieties in exports can lead to improved efficiency.

Conversely, owning the packhouse facility exhibits a negative coefficient, referring that firms with their own packhouse facilities tend to have lower efficiency. A possible explanation for this could be, as mango export is a seasonal activity and owning a packhouse facility permanently may cause its additional maintenance charges. The average volume per shipment shows a negative coefficient, implying that firms with higher average shipment volumes tend to have lower efficiency. While the relationship is not statistically very strong, it suggests that focusing on optimizing shipment volumes may be beneficial for efficiency. Largely, these results confirm the findings of tobit regression and provide practical guidance for the firms exporting mango to the aggregate market. Key takeaways include the importance of education, diversification in mango varieties, utilization of local packing boxes, and rented-in packhouse facilities to improve firms' efficiency for this market.

4.4.2 Technical efficiency of Specialized–EU exports

The descriptive statistics of the estimated efficiency scores for 44 firms in the Specialized–EU exports market have been presented in Table 4.8. Notably, all firms in this market fall within the efficiency range of 0.9 to 1, indicating a high level of technical efficiency among these firms. None of the firms recorded an efficiency level below 0.9, suggesting a collective proficiency in managing resources tailored for EU export requirements. This emphasizes a uniform and optimal operational performance among these firms. The minimum efficiency of 0.93 suggests that even the least efficient firm in the sample operates at a relatively high level. The mean efficiency score of the firms in this market is 0.98.

Table 4.8: Frequency distribution of firms' efficiency scores for Specialized–EU exports

Efficiency level	Frequency	Percentage
<0.90	0.00	0.00
0.90-1.00	44	100
Nr. of obs.		44
Minimum		0.93
Maximum		1.00
Mean		0.98
St. deviation		0.02

Source: Author's estimations

To assess the association of categorical determinants with efficiency scores in the Specialized–EU exports, the distribution of efficiency across different categories has been observed before regression estimations. This preliminary step is undertaken to identify the important categorical variables (potentially) affecting the efficiency. These dummy variables along with their estimated coefficients can be assessed further in regression analysis of this market (for instance, see Table 4.9).

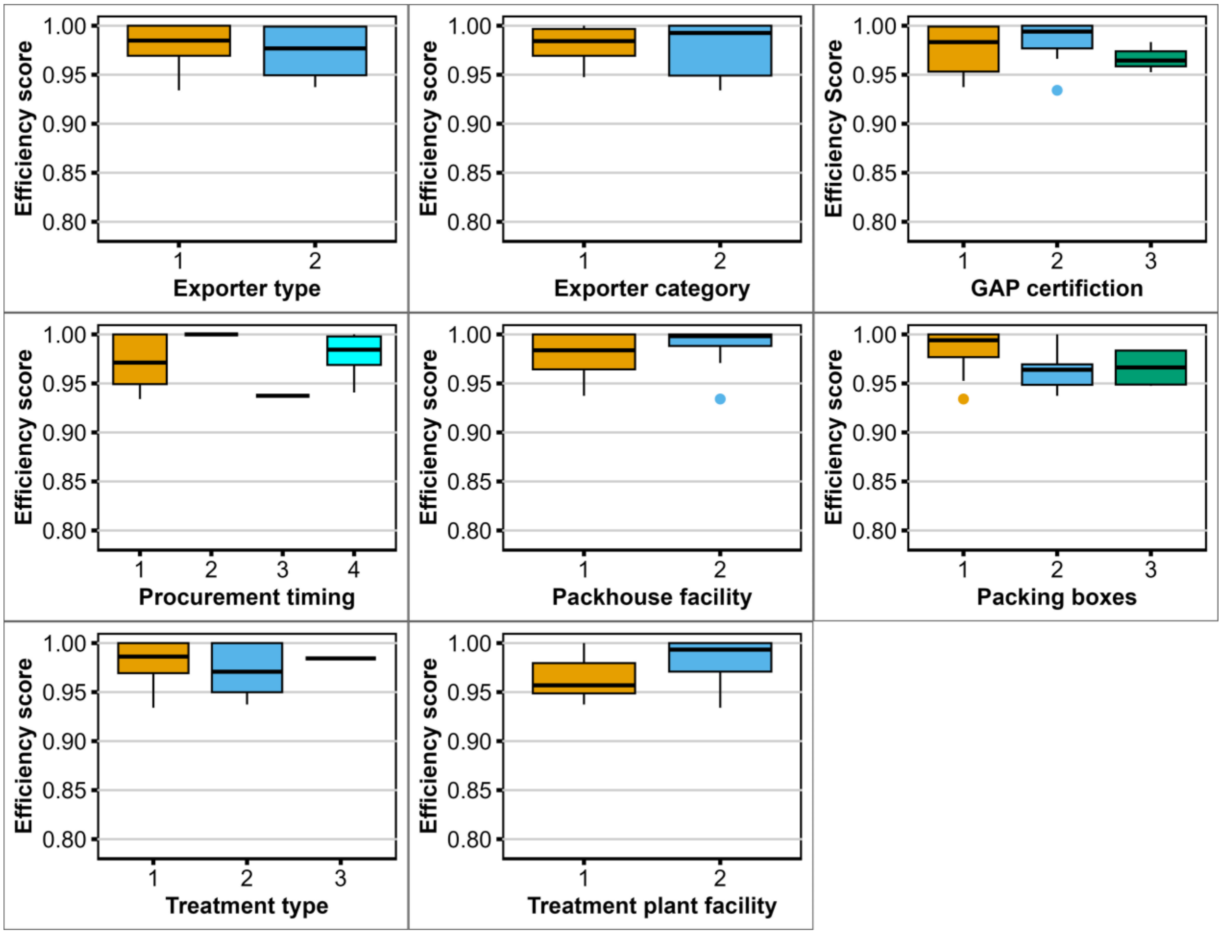

Figure 4.3: Distribution of firms' efficiency scores for categorical variables in Specialized-EU exports

Source: Author's illustration based on survey data (2014)

a) <u>Tobit regression</u>

With the utilization of censored regression, the efficiency of 14 firms out of 44 in Specialized–EU exports is found to be right-censored at 1. While estimating tobit regression, it was observed through VIF[22] that a few determinants of efficiency were exhibiting multicollinearity (see Appendix 4), including packhouse distance to the departure port, average volume per shipment, exporter type-sole, and treatment plant facility-owned. Among these collinear determinants, packhouse distance to the departure port has been dropped from tobit regression, leading to the condition of no multicollinearity among the rest of the determinants.

[22] A variance inflation factor (VIF) is a measure of multicollinearity in regression analysis.

The estimated coefficients of tobit regression model after the exclusion of one determinant for this market are presented in Table 4.9. The Wald statistic for this model is 35.5 (p-value<0.001), indicating that the explanatory variables included in the model collectively have a significant impact on explaining the variation in the dependent variable (technical efficiency). For variables related to firms' owners' characteristics, age exhibits a significant coefficient, while education and experience are found to be non-significant. The negative coefficient of age suggests that to obtain optimal efficiency of these firms exporting to EU only, the young exporters may contribute more efficiently than older exporters, due to their flexibility in adopting new innovations and ideas of enhancing the efficiency. Notably, in comparison with aggregate exports where the contribution of education was concluded as significant contributor, in Specialized–EU exports, the impact of education may not be significant in determining the efficiency.

Table 4.9: Factors associated with technical efficiency of firms in Specialized–EU exports (tobit regression)

Variables	Estimate	Std. error	z value	Pr. (>|z|)
Intercept	0.092	0.028	3.30	0.001***
Age (year)	-0.001	0.0003	-2.70	0.02**
Education (year)	-0.0002	0.001	-0.18	0.85
Experience (year)	-0.0004	0.001	0.77	0.43
Exporter type-sole	-0.022	0.013	-1.66	0.09*
Exporter category-independent	-0.015	0.01	-1.52	0.12
GAP certification-yes	0.007	0.01	0.68	0.04**
Procurement timing-early	-0.003	0.01	-0.26	0.79
Participation in exhibitions (nr./year)	-0.002	0.004	-0.43	0.66
Packing boxes-imported	0.013	0.011	-1.18	0.02**
Varieties exporting (nr./year)	0.007	0.004	1.65	0.09*
Packhouse facility-own	-0.009	0.012	-0.74	0.45
Average vol. per shipment (ton)	-0.030	0.009	-3.28	0.001***
Treatment type-HWT	0.005	0.01	-0.44	0.06*
Treatment plant facility-owned	0.003	0.002	-1.46	0.14
Log (scale)	-3.944	0.13	-28.53	0.00***

Note: *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively.
Source: Author's estimations

For dummy variables depicting the decisions for quality management and firms' characteristics, only sole exporters, getting the GAP certifications, varieties exporting, average volume per shipment, and use of treatment type HWT are found to be significantly affecting the efficiency of firms. The negative coefficient of sole exporters implies that exporters working in collaboration as group exporters hold more importance in securing better performance of firms in terms of export activities. The positive impact of GAP certification-yes for Specialized–EU exports depicts that it increases the export efficiency of firms by the fulfillment of one of the crucial requirements of exports to the EU. The importance of this certification for fruits exports was also highlighted by AHMAD et al., (2018) based on similar findings of export value chain assessment of citrus fruits in Pakistan. They emphasized that the non-compliance with GAP certifications for Pakistan's fruit exports adversely impacts the fruit quality, putting the country at a disadvantage compared to its competitors.

Matching in line with the requirement of good quality packing material for exports to the EU market, the coefficient of imported packing boxes also indicated its positive impact on the firm's efficiency. PADALIYA & PUNDIR (2022) in their study of challenges faced by mango exporters also supported this direct impact of imported packaging in the EU exports. MALIK et al., (2017) also presented positive impact of intelligent packaging on export of fresh and processed mango products.

Moreover, the positive coefficient for varieties exporting suggests that firms which export more mango varieties can achieve high efficiency. This finding is consistent with the aggregate exports. The average volume per shipment displays a negative coefficient which implies that firms with high shipment volumes may tend to have low efficiency. A possible explanation can be made, as large proportion of mango export is shipped via sea transport mode, so increasing the volumes per shipment can turn in increased loss & damage due to prolonged packing and storage.

Lastly, as the application of treatment type HWT is another crucial requirement for mango export to the EU market, the influence of this variable is also studied. Aligned with the market requirement, the impact of the HWT on exports to the EU is found positive, which means it contributes significantly to export efficiency in this market. Many studies also support this argument. In the study conducted by GÓMEZ-SIMUTA et al., (2017), it was demonstrated that HWT has been proved to be a successful commercial phytosanitary treatment in the context of mango exports. SARRWY et al., (2022) also highlighted the importance of HWT as mango being a highly perishable fruit encounters difficulties in preserving its quality during postharvest handling owing to rapid ripening. For this reason, HWT has gained global recognition for its potential in extending the shelf life of mango.

b) <u>Truncated regression</u>

Multicollinearity issue was also encountered in this model (via VIF values), see Appendix 5, among which the highest VIF value is found for packhouse distance to the departure port distance. Hence, this determinant is excluded to obtain reliable estimates of regression. The estimated coefficients for the rest of the variables are presented in Table 4.10. The results for the variables demonstrating the characteristics of exporters show that only age is a significant contributor to the efficiency of the firms while education and experience are accounted as non-significant factors. This aligns with the discussion of tobit results of this market.

Table 4.10: Factors associated with technical efficiency of firms in Specialized–EU exports (truncated regression)

Variables	Estimate	Std. error	t-value	Pr. (>|t|)
Intercept	0.90	0.019	55.87	0.00***
Age (year)	-0.001	0.0002	-3.347	0.001***
Education (year)	-0.0001	0.001	-0.209	0.83
Experience (year)	0.0002	0.0004	0.525	0.59
Exporter type-sole	-0.020	0.01	-2.066	0.03**
Exporter category-independent	-0.007	0.006	-1.105	0.26
GAP certification-yes	0.004	0.007	0.551	0.05**
Procurement timing-early	-0.001	0.007	-0.205	0.83
Participation in exhibitions (nr./year)	0.0001	0.003	0.058	0.95
Packing boxes-imported	0.010	0.007	-1.394	0.01***
Varieties exporting (nr.)	0.005	0.003	1.686	0.09*
Packhouse facility-own	-0.007	0.008	-0.893	0.37
Average volume per shipment (ton)	-0.019	0.007	-2.685	0.01***
Treatment type-HWT	0.003	0.007	-0.405	0.06*
Treatment plant facility-own	-0.011	0.011	-1.028	0.30
Sigma	0.014	0.001	9.38	0.00***

Note: *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively.
Source: Author’s estimations

Following the characteristics of exporters, the influence of firms’ characteristics on efficiency is accessed. Notably, only the exporter type-sole is found as significant determinant while exporter category-independent, early procurement timing, owing a packhouse facility and treatment plant facility has indicated non-significant effect on firms’ efficiency. The negative coefficient of exporter type-sole is consistent with the tobit regression and suggests that collaborative exporting (group exporters) may lead to higher efficiency in this market. Whereas, various determinants representing the export activities are found significant contributor to firms' efficiency, including the GAP certification, use of imported packing boxes, varieties exporting, average volume per shipment, and treatment type HWT. The positive coefficient of GAP certification, use of imported packaging, diversification of mango varieties in export, application of HWT, and negative impact of high shipment volumes coincide with the outcome of tobit model of this same market.

4.4.3 Technical efficiency of Diversified–EU exports

Frequency distribution of technical efficiency of 56 firms involved in Diversified–EU marketing is presented in Table 4.11. Notably, none of the firms in this market have efficiency score below 0.5, indicating that all firms are operating at a minimum level of moderate efficiency. Majority of the firms fall within the efficiency range of 0.9 to 1.00, indicating a significant proportion of highly efficient firms in this market. Notably, 14.28% of firms have efficiency scores in the range of 0.5 to 0.6, indicating a lower level of efficiency, while 19.64% fall in the 0.6 to 0.7 range. The mean efficiency score is 0.82, suggesting a high average level of technical efficiency across the 56 firms.

Table 4.11: Frequency distribution of firms' efficiency scores for Diversified–EU exports

Efficiency level	Frequency	Percentage
<0.50	0.00	0.00
0.50-0.60	8.00	14.28
0.60-0.70	11.0	19.64
0.70-0.80	6.00	10.71
0.80-0.90	9.00	16.07
0.90-1.00	22.0	39.29
Nr. of obs.		56
Minimum		0.50
Maximum		1.00
Mean		0.82
St. deviation		0.16

Source: Author's calculation

After the estimation of efficiency scores, its distribution across different levels of categorical determinants is examined to assess the impact of each category on the efficiency, so that the influential categories can be filtered out (Figure 4.4). As a result, eight categories were identified to be used as dummy variables in the regression models. Estimates of these dummy variables are provided in Table 4.12

along with the rest of the determinants. Additionally, two determinants (varieties exporting and average volume per shipment) have been excluded from the regression analysis due to their very weak correlation with the efficiency (see Appendix 3).

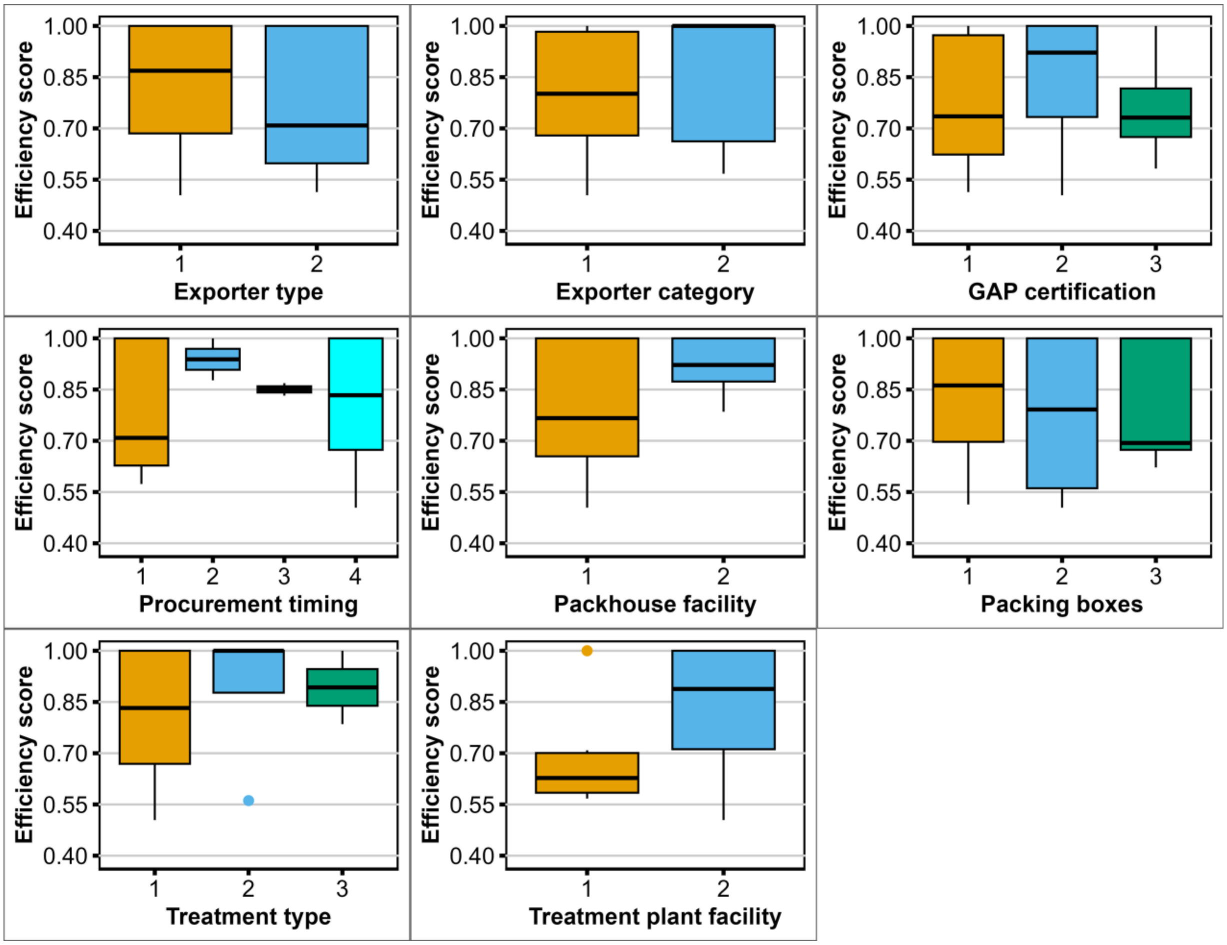

Figure 4.4: Distribution of firms' efficiency scores for categorical variables in Diversified–EU exports

Source: Author's illustration based on survey data (2014)

a) <u>Tobit regression</u>

For firms in the Diversified–EU export market, the efficiency of 18 firms out of 56 has been identified as censored at upper bound of 1. The estimations of tobit regression for this market reveal various statistically significant and economically relevant observations (see Table 4.12). The Wald statistic of this model is calculated as 25.28 (p-value<0.05), indicating that the model as a whole is statistically significant. Firstly, from the variables related to firm owner's characteristics, only education is highlighted as a significant factor determining the efficiency of firm whereas, the age and experience of the exporters are not found significant. Apparently, the education with a negative sign infers that having more formal education does not necessarily lead to increased efficiency. Similar findings for education were reported by ALVAREZ & CRESPI (2003) where it was implied that this unexpected result could be rationalized by considering that control activities result from a combination of knowledge, effort, and time spent overseeing the labor force. It is essential to note that this variable necessitates further investigation.

Table 4.12: Factors associated with technical efficiency of firms in Diversified–EU exports (tobit regression)

Variables	Estimate	Std. error	z value	Pr. (>|z|)
Intercept	-0.053	0.381	-0.139	0.89
Age (year)	-0.001	0.003	-0.166	0.86
Education (year)	-0.030	0.014	-2.146	0.03**
Experience (year)	-0.001	0.006	-0.093	0.92
Exporter type-sole	-0.012	0.132	-0.089	0.92
Exporter category-independent	0.005	0.111	0.042	0.96
GAP certification-yes	0.002	0.095	0.025	0.08*
Procurement timing-early	0.426	0.213	1.997	0.04**
Procurement timing-mixed	0.131	0.155	0.848	0.39
Participation in exhibitions (nr./year)	-0.052	0.048	-1.082	0.27
Packing boxes-local	0.045	0.111	0.407	0.68
Packing boxes-mixed	0.368	0.166	2.222	0.02**
Packhouse facility-own	-0.153	0.109	-1.404	0.16
Packhouse to dep. port distance (km)	0.014	0.049	0.289	0.77
Treatment type-HWT	0.126	0.125	-1.013	0.03**
Treatment plant facility-hired	0.236	0.118	1.993	0.04**
Log (scale)	-1.448	0.123	-11.779	0.00***

Note: *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively.
Source: Author's estimations

For variables related to firms' characteristics and export activities for quality management, the fulfillment of GAP certification, early procurement timing, packing boxes-mixed, treatment type-HWT, and hired treatment plant facility have significant influence on efficiency of firms in this market. The positive impact of GAP certification highlights its importance to enhance the efficiency in Diversified–EU exports. The early procurement timing with a positive coefficient suggests that firms that procure mangoes early tend to have higher efficiency scores as compared to late and mixed procurement timings. The positive influence of the use of mixed packing boxes implies that firms using a mix of local and imported packing boxes tend to have high efficiency. Similarly, the positive coefficient of HWT means that firms preferring HWT over HWD and VHT have better export efficiency. Lastly, the hired treatment plant facility with a positive coefficient indicates that outsourcing treatment plant processes may be more efficient than owning and operating it.

b) Truncated regression

The estimated coefficients obtained from the truncated regression for Diversified-EU exports are presented in Table 4.13. The negative coefficient of education is consistent with tobit results of this market. It implies that highly educated exporters may need to prioritize other factors to enhance their firms' export efficiency. Apart from the procurement timing-early, the significance of rest of the variables including fulfillment of GAP certification, the use of mixed packing boxes, treatment type of HWT, and hired treatment plant facility aligns with the discussion of tobit regression. In addition of these variables, owning a packhouse plant facility is found significant with a negative sign. It infers that hiring a packhouse facility may lead to have better efficiency as compared to owning one.

Table 4.13: Factors associated with technical efficiency of firms in Diversified–EU exports (truncated regression)

Variables	Estimate	Std. error	t-value	Pr. (>|t|)
Intercept	0.870	0.200	4.352	0.00***
Age (year)	-0.0001	0.002	-0.054	0.95
Education (year)	-0.016	0.007	-2.21	0.02***
Experience (year)	0.0002	0.003	0.091	0.92
Exporter type-sole	0.001	0.067	0.015	0.98
Exporter category-independent	0.025	0.058	0.439	0.66
GAP certification-yes	0.005	0.050	0.092	0.02**
Procurement timing-early	0.145	0.102	1.429	0.15
Procurement timing-mixed	0.030	0.082	0.369	0.71
Participation in exhibitions (nr./year)	-0.030	0.026	-1.147	0.25
Packing boxes-local	0.015	0.058	0.258	0.79
Packing boxes-mixed	0.160	0.081	1.984	0.04**
Packhouse facility-own	-0.092	0.058	-1.592	0.10*
Packhouse to dep. port distance (km)	0.012	0.026	0.454	0.65
Treatment type-HWT	0.046	0.067	-0.691	0.09*
Treatment plant facility-hired	0.123	0.064	1.935	0.05*
Sigma	0.134	0.013	10.583	0.00***

Note: *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively.
Source: Authors' estimations

4.5 Summary and conclusion

This chapter focused on efficiency evaluation through its determinants for Pakistan mango exporting firms, for three different markets viz; the Aggregate, Specialized–EU, and Diversified–EU exports. In Aggregate exports, the tobit regression revealed that the young exporters contribute more to the efficiency of the firm as compared to older exporters, while higher education levels influence positively. Exporting a great variety of mangoes and using local packing boxes are also associated with high efficiency in this market. However, having one's packhouse facility is linked to achieving lower efficiency. Similar findings were found in truncated regressions for this market, where determinants including education, diversification in varieties exporting, average volume per shipment, and packing boxes-local showed having positive impact on efficiency of firms, while the older exporters and owning a packhouse facility exhibited negative effect.

In Specialized–EU exports also, tobit and truncated regressions indicated that firms with older owners experience lower efficiency, and diversifying mango varieties can lead to improvements. High shipment volumes are associated with low efficiency, and sole exporters may have lower efficiency than group exporters. In the efficiency analysis of mango exporters targeting Diversified–EU market, tobit regression results reveal that education is a significant factor affecting efficiency. Early procurement and use of mixed packing boxes is positively associated with efficiency. Outsourcing the treatment plant facility and packhouse facility also positively influences efficiency in this market.

This chapter underscores several policy implications for enhancing the efficiency of Pakistan's mango exporting firms. Firstly, younger exporters need to be encouraged, recognizing their positive impact on firm’s efficiency. Policy initiatives that promote education within the industry can also contribute to competitiveness in international markets. Diversification in mango varieties emerges as a crucial strategy, particularly for Specialized–EU exports, where it positively influences efficiency. Government should also facilitate the adoption of a diverse range of packing boxes to further enhance export efficiency. Notably, careful consideration is needed regarding packhouse facility ownership, as findings suggest a potential negative impact on efficiency. Additionally, the outsourcing of treatment plant and packhouse facilities emerges as a viable strategy for improving efficiency, warranting further exploration and support. Overall, an extensive policy framework that integrates these insights can propel the mango exporting sector towards greater efficiency and international competitiveness.

5 DETERMINANTS OF MANGO EXPORT

In this chapter, the export margin and determinants of mango export from Pakistan to three distinct markets viz; the Aggregate, Specialized–EU, and Diversified–EU exports are discussed. Based on the primary data, it is aimed to evaluate the exporters' export performance and investigate the impact of exporter's socio-economic and firm's export-related and cost-related determinants on mango export volumes. In the export margin analysis, different export-related costs and return variables are calculated. To quantify the influence of key determinants on mango exports for all the markets, the OLS regression is employed, based on data properties and its suitability for the analysis.

5.1 Introduction

From a firm's business point of view, exporting agricultural products revolves around profitability, gauged by understanding the costs and returns (GHAFOOR et al., 2013). The average purchase price, transportation cost, and marketing costs significantly impact the overall cost of exporting a product, affecting profitability. The sale price is equally important, as it determines the returns from exports. Higher sale prices in international markets contribute to better returns. To understand the impact of these factors on mango exports, an analysis of export margins has been conducted, along with identifying key determinants influencing mango exports.

Being Pakistan's one of the most sought-after export commodities, mangoes have captivated international markets, making them a coveted commodity in agricultural exports. As Pakistan endeavors to harness its export potential and capitalize on the global demand for mangoes, it becomes imperative to explore the intricate interplay of factors influencing its trade.

This chapter focuses on a comprehensive exploration of the export margin analysis (EMA) of Pakistan firms, predominantly situated in the provinces of Punjab and Sindh, with a primary focus on their exports to three distinct market models, i.e., Aggregate, Specialized–EU, and Diversified–EU exports. Comparison of these different market models offers a variety of market situations, each with its unique challenges and opportunities. This approach illuminates the diverse dynamics at play within these markets, allowing for a nuanced understanding of export behavior. Secondly, an integral facet of this chapter is the identification of the determinants influencing total mango export.

The findings of this analysis may have a direct impact on the business strategies of firms engaged in mango exports. These firms can utilize the empirical insights gained from the EMA to optimize their export behavior, thereby enhancing their competitiveness in the global market. Furthermore, the identification of determinants of mango exports derived from ordinary least squares (OLS) regression and ridge regression can provide practical guidance for business decision-making. It can help firms prioritize factors that truly influence their export performance, allowing for resource allocation and strategic planning based on data-backed insights.

5.2 Analytical framework

The export margin analysis aims to assess the net profitability of mango exporters in each export market. If M_c stands for the marketing costs incurred by exporters including purchase & production cost, transportation cost, packing cost, etc. and S_p denotes the sale price, then the gross margin (G_m) earned by mango exporters is calculated by

$$G_m = S_p - M_c \tag{5.1}$$

Similarly, the net margin (N_m) of mango exporters, indicating their profit after tax (T) deduction from gross margin (G_m), is calculated by using the formula,

$$N_m = G_m - T \tag{5.2}$$

The second objective of this chapter after EMA is, to quantify the impact of major variables, which directly or indirectly affect mango exports (Y_m) of mth firm, from Pakistan to different markets. For its estimation, the following functional form has been introduced from the OLS regression model.

$$Y_m = f(S, D, C) \tag{5.3}$$

The specific form of this model becomes,

$$Y_m = \alpha S_i^{\beta_i} D_j^{\gamma_j} C_k^{\delta_k} + \epsilon_l^{\varepsilon} \tag{5.4}$$

In equation (5.4), S_i (for i = 1, 2, 3) represents the socio-economic variables of mango exporters, D_j (for j = 1, 2, …, 9) represents qualitative (dummy) variables, and C_k (for k = 1, 2, …, 14) indicates cost (business) variables of mango exporting firms. Estimation of an OLS regression model with approximately 26 predictors (35 after one-hot encoding[23] of dummy variables) emerged as a challenge to obtain reliable estimates while addressing the issue of multicollinearity and handling large number of dummy variables. Such a scenario can potentially lead to an over-fitted model when dealing with a limited number of observations, especially in the case of Specialized–EU exports with 44 firms only. Hence, to identify the few most influential determinants of total mango exports, along with dealing the multicollinearity, a statistical approach named Ridge regression has been utilized.

Ridge regression is an estimation technique employed to address the issue of multicollinearity, ultimately leading to dimension reduction in regression model. Classical theory contends that extensive models tend to over-fit the data, necessitating significant regularization to facilitate their ability to generalize (TSIGLER & BARTLETT, 2020). The model in equation (5.4) can be presented in standard regression form as follows,

$$Y = X\beta + \varepsilon \tag{5.5}$$

In this regression model, Y represents the dependent variable of order $M \: x \: 1$, which in this case is the total mango export quantity of the mth firm, X is a matrix of non-stochastic (fixed) regressors with $M \: x \: N$ order, which in this study are; socio-economic, dummy and cost-related variables. β is a $N \: x \: 1$ vector denoting the unknown regression coefficients, and ε is a $M \: x \: 1$ vector encompassing the unknown disturbances. According to GUILEY & MURPHY (1975), when ε adheres to standard assumptions, the best linear unbiased estimator of β is computed as follows,

$$\hat{\beta}_{ols} = (X'X)^{-1}X'Y \tag{5.6}$$

Whereas, the standard error of $\hat{\beta}_{ols}$, i.e., *var(*$\hat{\beta}_{ols}$*)* is given as

$$var(\hat{\beta}_{ols}) = \sigma^2(X'X)^{-1} \tag{5.7}$$

When the explanatory variables (X's) exhibit multicollinearity, the variance of $\hat{\beta}$ can inflate to an unreasonable extent, undermining the reliability of $\hat{\beta}$ as an estimate of β. Mathematically, it becomes impossible to compute the inverse of the covariance matrix among the independent variables. One of the reasons of failure in obtaining a reliable estimate of β is the inclusion of dummy explanatory variables. As ALLEN (1997) stated, traditional OLS estimation methods become infeasible by manifesting regression analysis involving dummy variables if the exclusion of one category of a

[23] It is a method which has been used to represent categorical variables as numerical values in a regression model.

categorical variable from the analysis is overlooked. If all categories of a categorical variable are included as binary variables in the regression equation, the intercept becomes a straightforward additive function of these binary variables. Therefore, one category has to be treated as reference to other categories.

A potential solution to mitigate this issue is the ridge estimator proposed by HOERL & KENNARD (1970). This method reduces the variance of the estimates, albeit at the cost of introducing a certain level of bias. This is achieved by augmenting each of the diagonal elements of the matrix $X'X$ with a small positive value, denoted as λ_i. The resultant estimator is expressed as follows,

$$\hat{\beta}_{ridge} = (X'X + \lambda)^{-1}X'Y \tag{5.8}$$

From equation (5.8), λ is the regularization parameter or shrinkage term, also known as the ridge parameter with a condition i.e., $0 < \lambda < 1$. It is defined as,

$$\lambda_{NxN} = \begin{bmatrix} \lambda_1 & 0 & \cdots & 0 \\ 0 & \lambda_2 & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & \lambda_N \end{bmatrix} \tag{5.9}$$

It is expected that by tolerating a certain degree of bias, which is by the introduction of λ, a more substantial reduction in the variance of β can be attained, ultimately resulting in an overall decrease in mean square error (DRAPER & VAN NOSTRAND, 1979). Hence, with the introduction of the shrinkage parameter, the coefficients (weights) of explanatory variables having minimum impact on the dependent variable will be reduced to zero, without inflated standard errors. These variables will eventually be excluded from OLS regression model. This meticulous approach aims to enhance the accuracy and interpretability of regression results, ensuring that the findings are both statistically sound and meaningful.

5.3 Export margin analysis

Export margin analysis (EMA) serves as a key for comprehending the intricacies of the mango export economics of Pakistan. In its essence, EMA is a method used to evaluate the export performance of international trade, concerning key variables. It enables one to measure how changes in these variables impact the profitability and competitiveness of exporting enterprises. It provides the key drivers of export profitability, serving as a guiding source for businesses, in optimizing export strategies and fostering economic growth.

5.3.1 Variables description

This section describes the key variables involved in export margin analysis. These variables encompass a spectrum of costs, margins, and financial elements integral to the profitability of Pakistan mango exports. From production costs to international freight charges and net export margins, this section unveils the components that contribute to the economic viability of mango exports. The variables involved in EMA along with their descriptive statistics for 100 firms are given in Table 5.1.

The mean of 33.59 Rs/kg of purchase & production cost reflects the average rate at which mango is sourced. The standard deviation of 11.10 Rs/kg indicates that costs are fairly stable among all of the 100 firms. For transportation cost, a low standard deviation of 4.05 Rs/kg implies less variation in distances to ports or methods of transportation. Most of the storage costs are close to zero given the mean 0.78 Rs/kg. The treatment verification cost with a low standard deviation of 1.26 Rs/kg appears to be relatively consistent across all firms. With a low mean and standard deviation, other charges don't seem to be a dominant cost driver. For sale price, the mean is considerably higher than the final export cost, indicating a healthy margin.

Table 5.1: Summary statistics of cost-related variables in export margin analysis

Variables	Min	Max	Mean	St. Dev
Purchase & production cost (Rs/kg)	12.00	62.50	33.59	11.10
Domestic transportation cost (Rs/kg)	0.56	22.06	5.77	4.05
Storage cost (Rs/kg/day)	0.00	11.11	0.78	2.09
Treatment cost (Rs/kg)	5.00	35.00	16.53	7.54
Treatment verification cost (Rs/kg)	0.91	6.99	3.04	1.26
Cooling cost (Rs/kg)	0.00	6.00	0.60	1.52
Packing cost (Rs/kg)	7.00	32.10	16.05	5.30
Clearing agent cost (Rs/kg)	0.00	6.79	0.96	0.90
Freight forwarder cost (Rs/kg)	0.00	11.84	2.31	2.00
International freight cost (Rs/kg)	61.67	248.00	134.75	42.91
Loss & damage cost (Rs/kg)	0.60	11.00	5.16	2.33
Labor cost (Rs/kg)	1.83	75.00	14.71	14.86
Other charges (Rs/kg)	0.15	2.08	0.70	0.39
Final export cost (Rs/kg)	140.66	368.37	234.96	53.01
Final export cost (USD/kg)	1.41	3.68	2.34	0.53
Sale price (USD/kg)	2.57	8.93	4.70	1.17
Tax paid (USD/kg)	0.04	0.13	0.07	0.02

Exchange rate: 1 USD = 100 Rs (2014)
Source: Author’s calculation

5.3.2 Results and discussion

a) <u>Export margin analysis of Aggregate exports</u>

For aggregate exports, the high variable costs activities i.e., international freight cost of 134.75 Rs/kg and purchase & production price 33.59 Rs/kg are the most dominant contributors to the overall export cost (Table 5.2). The treatment costs along with the treatment verification cost collectively add up to 19.57 Rs/kg. Given the importance of meeting international quality standards, particularly for the EU market, these costs might be hard to minimize but could be optimized through technology and automation. The labor and packing costs appear to be other influential cost centers (14.70 Rs/kg and 16.04 Rs/kg respectively). Costs like storage, cooling, and other charges seem to be fairly low. Nevertheless, even small reductions in these areas could lead to important savings given the volume of exports. The final export cost in local currency is 234.96 Rs/kg, equivalent to 2.34 USD/kg.

Table 5.2: Export margin of firms in Aggregate market

Activity	Average cost (Rs/kg)	Average cost (USD/kg)
Purchase & production cost	33.59	0.330
Domestic transport cost	5.77	0.057
Storage cost per day	0.77	0.007
Treatment cost	16.53	0.165
Treatment verification cost	3.04	0.030
Cooling cost	0.60	0.006
Packing cost	16.04	0.160
Clearing agent cost	0.96	0.009
Freight forwarder cost	2.31	0.020
International freight cost	134.75	1.340
Loss & damage cost	5.15	0.050
Labor cost	14.70	0.140
Other charges	0.70	0.007
Final export cost	234.96	2.340
Sale price	470.00	4.700
Gross export margin	236.00	2.360
Tax paid	7.00	0.070
Net export margin	229.00	2.290

Exchange rate: 1 USD = 100 Rs (2014)
Source: Author's calculations

The Gross export margin is 2.36 USD/kg, but after accounting for tax, the net export margin comes down to 2.29 USD/kg. While the gross margin appears healthy, given the high variable costs, there is a potential risk if any of the major costs see an increase; the net margin can significantly drop. For tax considerations, the tax paid is relatively low at 0.07 USD/kg. However, changes in trade regulations or tax rates in Pakistan can impact the net margins. Currency exchange rates for a country like Pakistan are volatile; any drastic change can affect the net margins substantially. Lastly, the loss & damage cost of 5.15 Rs/kg indicates the potential quality issues or supply chain inefficiencies for the firms under aggregate exports, that need to be addressed to improve the overall margin.

Table 5.2 reveals that while exporting mangoes appears profitable with a healthy net export margin of 2.29 USD/kg, there are multiple levers and risk factors that need to be managed effectively. The largest cost contributor is international freight cost, followed by purchase & production and packing costs. These are key areas that can be attributed to cost optimization strategies. The very existence of a loss & damage cost item suggests a need for better quality control and supply chain management to improve profitability.

a) Export margin analysis of Specialized–EU exports

The export margin analysis for the firms under Specialized–EU exports reveals a slightly different cost structure than the aggregate exports market. This analysis is crucial for identifying specific areas where cost optimization can occur or where strategic investments should be focused to ensure a competitive edge. Table 5.3 provides a cost breakdown per kg in local currency (Rs) as well as USD, with a final export cost of 244.64 Rs/kg or 2.44 USD/kg.

Similar to aggregate exports, in this market also, international freight cost is the highest variable cost at 143.80 Rs/kg, but more substantial, probably because exporters choose reliable freight carriage services. These costs are very susceptible to fuel market fluctuations also. Purchase & production costs have gone slightly down to 32.18 Rs/kg compared to the aggregate market. It indicates that mangoes targeted for the Specialized–EU exports might be sourced more efficiently or selectively, possibly due to higher quality requirements. Labor and packing costs are slightly higher in the Specialized–EU exports at 16.20 Rs/kg and 16.23 Rs/kg, respectively. The specialized nature of this market might necessitate higher labor costs for sorting, grading, or specialized packing to meet EU standards. Treatment and its verification costs (16.13 Rs/kg and 3.25 Rs/kg) are also crucial aspects to consider. Since the EU market has strict quality assurance regulations, these costs might be inevitable but could be optimized with the help of the government in providing treatment plants to exporters. The costs such as storage, cooling, and other charges are relatively low but have seen a small increase compared to the generic market. Even small optimizations in these areas can bring a substantial impact due to the volume of exports.

The gross export margin in Specialized–EU exports stands at 2.85 USD/kg. It is obtained by subtracting the final export cost of 2.45 USD/kg from the sale price of 5.30 USD/kg. Compared to the aggregate exports, the gross export margin in the Specialized–EU exports is noticeably higher. The net export margin is 2.78 USD/kg, which is the gross export margin minus the tax paid. Interestingly, the net export margin in Specialized–EU exports is also higher compared to the aggregate exports. This indicates that, despite higher international freight and treatment verification costs, the exporters can get a high sale price in this market, thereby yielding higher profits.

Table 5.3: Export margin of firms in Specialized–EU market

Activity	Average cost (Rs/kg)	Average cost (USD/kg)
Purchase & production cost	32.18	0.32
Domestic transport cost	5.37	0.05
Storage cost per day	1.133	0.01
Treatment cost	16.13	0.16
Treatment verification cost	3.25	0.03
Cooling cost	0.85	0.008
Packing cost	16.23	0.16
Clearing agent cost	1.059	0.01
Freight forwarder cost	2.43	0.02
International freight cost	143.80	1.43
Loss & damage cost	5.24	0.05
Labor cost	16.20	0.16
Other charges	0.72	0.07
Final export cost	244.64	2.45
Sale price	530.00	5.30
Gross export margin	285.00	2.85
Tax paid	7.90	0.079
Net export margin	278.00	2.78

Exchange rate: 1 USD = 100 Rs (2014)
Source: Author’s calculations

b) Export margin analysis of Diversified–EU exports

Export margin analysis for Diversified–EU exports provides an opportunity for understanding the mango trading of those EU exporters who are also involved in non-EU exports. The gross and net export margins are critical elements that need to be examined for a comprehensive understanding of firms' business efficiency in this export market. Like other markets, international freight cost is the highest cost component at 151.85 Rs/kg. With it being even higher than in the Specialized–EU exports, this component of the cost structure needs to be optimized. The purchase & production cost here is 37.09 Rs/kg, which is the highest among all the markets.

The labor and packing costs are slightly lower than in Specialized–EU exports at 13.54 Rs/kg and 14.23 Rs/kg, respectively. This could indicate economies of scale or the use of less specialized labor and packing material. Treatment and verification costs remain roughly the same, indicating that compliance with EU standards is constant across different EU market types. This market has a final export cost of 252.69 Rs/kg or 2.52 USD/kg and a sale price of 5.25 USD/kg.

Table 5.4: Export margin of firms in Diversified–EU market

Activity	Average cost (Rs/kg)	Average cost (USD/kg)
Purchase & production cost	37.09	0.37
Domestic transport cost	6.04	0.06
Storage cost per day	0.49	0.004
Treatment cost	16.83	0.16
Treatment verification cost	2.94	0.02
Cooling cost	0.41	0.004
Packing cost	14.23	0.14
Clearing agent cost	0.83	0.008
Freight forwarder cost	2.12	0.02
International freight cost	151.85	1.51
Loss & damage cost	5.54	0.05
Labor cost	13.54	0.13
Other charges	0.74	0.007
Final export cost	252.69	2.53
Sale price	525.00	5.25
Gross export margin	272.00	2.72
Tax paid	7.80	0.078
Net export margin	265.00	2.65

Exchange rate: 1 USD = 100 Rs (2014)
Source: Author's calculations

The gross export margin indicates the gross revenue per kg of mangoes before taxes are accounted for. At 2.72 USD/kg, the gross export margin is slightly lower than the Specialized–EU exports but higher than the aggregate market. It offers good profitability before considering the tax implications. A relatively similar tax paid (0.078 USD/kg) as in previous markets implies consistent tax rate. Lastly, the net export margin of 2.65 USD/kg, after accounting for the tax, is suggesting greater profitability in the Diversified–EU exports also. It is the actual profit after all costs including tax are deducted and gives a more accurate measure of the financial viability of exporting to the Diversified–EU exports. To provide a view into the net export margins (USD/kg) across all the markets, a bar chart illustration is presented in Figure 5.1.

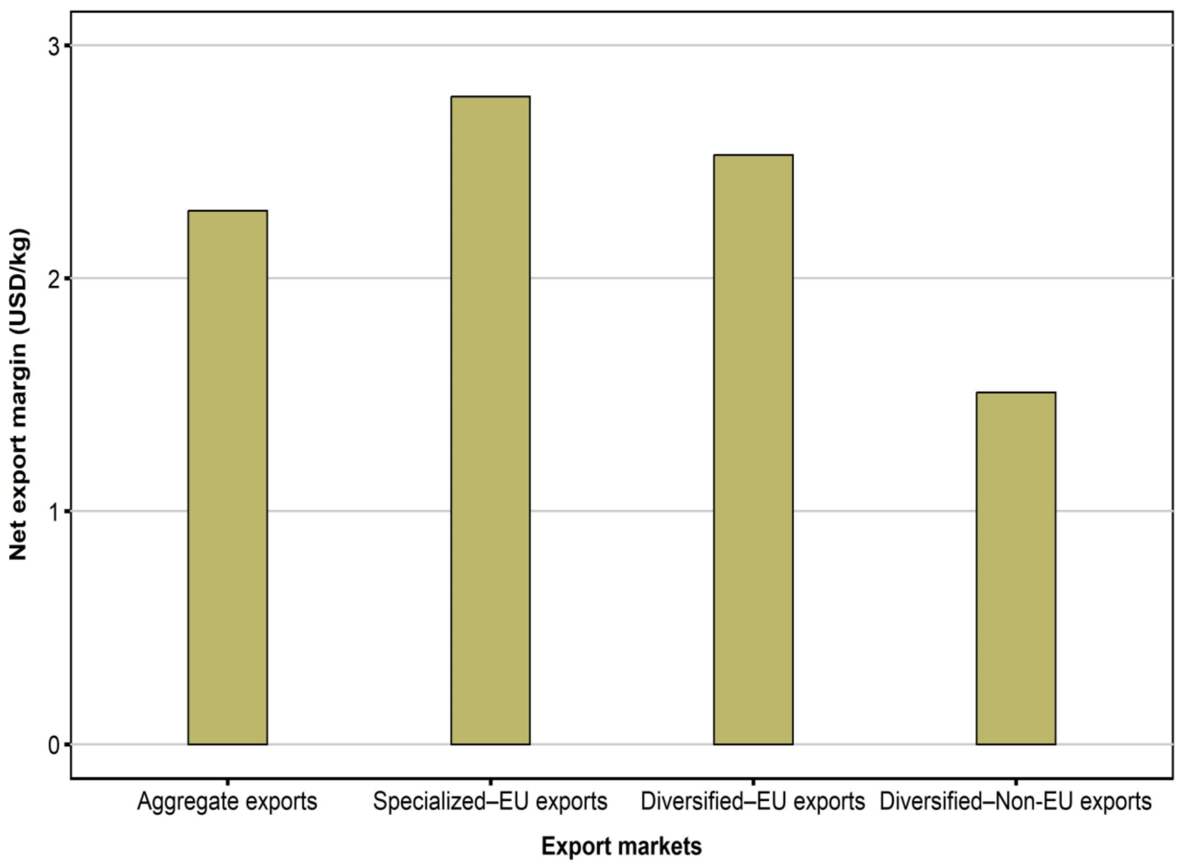

Figure 5.1: Comparison of net export margin for four different markets

Source: Author’s illustration based on survey data (2014)

Note: Refer to Appendix 10 for Diversified-Non-EU exports

In summary, aggregate exports exhibit a net export margin of 2.29 USD/kg, suggesting favorable profitability in this broader market category. On the other hand, Specialized–EU exports boast the highest margin at 2.78 USD/kg, indicating potentially advantageous conditions for mango exporters in this market. Diversified–EU exports maintain a competitive margin of 2.53 USD/kg. In contrast, Diversified–non-EU exports display a margin of 1.51 USD/kg, indicative of a somewhat less lucrative export environment outside the EU. These net export margins not only provide overview on the financial outcomes within each market but also serve as key indicators for exporters in the mango export industry, offering interesting findings into the profitability and potential opportunities within distinct export markets.

5.4 Determinants of Pakistan mango export

A pivotal component of this chapter is to identify and quantify the influence of different variables on mango export of firms in different markets for which export margin analysis has previously reported. A statistical method, OLS regression has been used to examine the relationship between various factors (determinants) and the total quantity of mango exported in tons per season. The variables used and the insights obtained from regression analysis has been discussed further.

5.4.1 Variables description

To understand the factors that influence the total mango exports, this section begins with a thorough descriptive exploration of a diverse range of determinants. These determinants are divided into three distinct categories. The first category of variables is exporters' socio-economic characteristics; including age, education, and experience, which significantly impact business performance. An educated and experienced individual is expected to make informed decisions compared to someone lacking in it (NAZEER et al., 2019). These factors are considered pivotal for enhancing the performance of mango exporters. The descriptive statistics for these variables are presented in Table 5.5.

Table 5.5: Summary statistics of socio-economic variables for total mango export

Socio-economic variables	Min	Max	Mean	St. deviation
Age (year)	23	75	46.75	11.92
Education (year)	0	16	10.42	3.94
Experience (year)	1	50	14.02	10.92

Source: Author's calculation

There is a wide age range among the exporters (min. 23, max. 75). Education ranges from a minimum of 0 (no education) to a maximum of 16 years (postgraduate or higher). The mean education level is approximately 10.42 years which suggests that on average exporters have completed 10 years of formal education. Experience ranges from a minimum of 1 year to a maximum of 50 years, indicating a wide range of experience levels. The impact of education has been observed by converting it into an ordinal categorical variable with three levels (basic, secondary, and higher).

The second category, a set of dummy variables based on the properties of firms, provides a view of the distinctive features of export business. These variables include the nr. of shipments per season, source of the initial supply, procurement timing, good agricultural practices (GAP) certification, etc. Each of these determinants presents an overview of the properties of 100 firms that are crucial in regression analysis. It is important to mention that due to extreme outlier observations in the determinant shipments (nr./season) (see Table 3.7), it has been categorized based on each market model and will be defined separately in subsequent sections.

From Table 5.6, it can be concluded that the majority of the firms source their initial mango supply directly from the farmers, while a notable minority engaged in self-production. Flexibility in purchase timing is prevalent, particularly with the mixed category, suggesting adaptability to market conditions. A notable number of firms lack GAP certification, while a substantial proportion has received this accreditation. Most exporters operate independently as sole exporters, while a smaller group as grower-cum exporters. Hot water treatment (HWT) is the preferred method of mango treatment among firms, while the presence of its treatment plant facilities is relatively limited. Packhouse registration is common among exporters, signifying adherence to government regulations, though a small number of exporters lack in it.

Table 5.6: Summary statistics of dummy variables for total mango export

Dummy variables	Levels	Category (frequency)
Source of initial supply	5	Own production (22), Farmer (28), Contractor (16), Wholesaler (13), Mixed (21)
Procurement timing	4	Early (16), Mid (4), Late (3), Mixed (77)
GAP certification	3	Yes (33), No (47), Mixed (20)
Exporter type	2	Sole exporter (75), Grower-cum exporter (25)
Exporter category	2	Independent (71), Group (29)
Treatment type	3	HWT (75), HWD (22), VHT (3)
Treatment plant facility	2	Yes (21), No (79)
Packhouse facility	2	Own (82), Rent (18)
Packhouse registration	2	Yes (72), No (28)
Nr. of shipments	3	Low (87), Moderate (7), High (6)

Source: Author’s calculations

Moreover, the incorporation of categorical information is to be handled by hot-encoding dummy variables, allowing for the representation of each category as a separate variable in the regression analysis. This specific approach will make the interpretation of regression coefficients straightforward. Each binary-encoded variable represents the presence or absence of a specific category. Consequently, the coefficients associated with these dummy determinants indicate the impact of each category on the dependent variable compared to the reference category.

The third category, cost-related variables, depicts the financial aspects of mango exports. These variables encompass purchase & production cost, storage cost, transportation expenses, treatment cost, and various other monetary aspects. Summary statistics for the cost-related determinants is provided in Table 5.7. The total mango export (ton/season), which is the dependent variable in OLS regression analysis, with very high substantial variability in export volumes, is heavily right-skewed, indicating the presence of a few extremely high-volume exports.

Table 5.7: Summary statistics of cost-related variables for total mango export

Cost-related variables	Min	Max	Mean	St. Dev
Total mango export (ton/season)	4.21	8824.25	338.02	1081.44
Purchase & production cost (Rs/kg)	12.00	62.50	33.59	11.10
Domestic transportation cost (Rs/kg)	0.56	22.06	5.77	4.05
Storage cost (Rs/kg/day)	0.00	11.11	0.78	2.09
Treatment cost (Rs/kg)	5.00	35.00	16.53	7.54
Treatment verification cost (Rs/kg)	0.91	6.99	3.04	1.26
Cooling cost (Rs/kg)	0.00	6.00	0.60	1.52
Packing cost (Rs/kg)	7.00	32.10	16.05	5.30
Clearing agent cost (Rs/kg)	0.00	6.79	0.96	0.90
Freight forwarder cost (Rs/kg)	0.00	11.84	2.31	2.00
International freight cost (Rs/kg)	61.67	248.00	134.75	42.91
Loss & damage cost (Rs/kg)	0.60	11.00	5.16	2.33
Labor cost (Rs/kg)	1.83	75.00	14.71	14.86
Other cost (Rs/kg)	0.15	2.08	0.70	0.39

Source: Author's calculations

The purchase & production cost incurred by the exporter is 33.59 Rs/kg on average while loss & damage costs have an average of 5.77 Rs/kg. In comparison, storage costs are quite low with an average of 0.78 Rs/kg/day. Similarly, packing cost vary from 7.00 Rs/kg to 32.10 Rs/kg with a moderate variability of 5.30 Rs/kg. Clearing agent, labor, and freight forwarder costs starting from zero, have a low variability of

0.90 Rs/kg and 2.00 Rs/kg. Lastly, international freight cost with an average of 134.75 Rs/kg has high variability of 42.91 Rs/kg as compared to other costs.

5.4.2 Results and discussion

a) Regression analysis of Aggregate exports

In the pursuit of understanding and identifying the key determinants of mango export for aggregate market, the ridge regression has been undertaken before conducting OLS regression. Ridge regression is chosen to ensure the validity and reliability of regression analysis while considering the overall a large number of determinants related to firms' owners characteristics and dummy determinants presented in section 5.4.1. The ridge regression not only serves as a dimensionality reduction method here but also aids in the selection of influential determinants having more weightage on the total mango export in the aggregate exports. Subsequently, the OLS regression has been conducted using the essential determinants identified through ridge regression, providing a robust foundation for uncovering the key determinants of mango exports from Pakistan.

Table 5.8 represents the results obtained from ridge regression depicting the weight associated with each socio-economic and dummy variable for potentially determining the total mango export quantity. It can be observed that out of socio-economic characteristics, education-higher holds substantial weights in comparison with other export related variables, hence this variable will be analyzed in the OLS regression for aggregate exports.

Secondly, for the selection variables from the dummy variables of firm's activities, it is observed that source of initial supply-wholesaler, exporter category-group, treatment type-HWD, procurement timing-mid, GAP certification-no, treatment plant facility-no, packhouse registration-no, shipments-moderate, and shipments-high leads rest of the other categories based on the ridge weights. Therefore, the selected variables based on ridge findings, and the cost related determinants with substantial contribution to the export margin in aggregate exports are presented in Table 5.9.

Table 5.8: Weights of determinants of total mango export in Aggregate market

Determinants	Ridge coefficients	Determinants	Ridge coefficients
Intercept	4.357	GAP certification-no	-0.158
Age (year)	0.001	GAP certification-mixed	0.120
Education-secondary	0.048	Exporter type-grower-cum exporter	0.030
Education-higher	0.106	Exporter category-group exporter	-0.141
Experience (year)	0.008	Treatment type-HWD	-0.133
Source of initial supply-farmer	0.051	Treatment type-VHT	0.119
Source of initial supply-contractor	-0.081	Treatment plant facility-no	-0.134
Source of initial supply-wholesaler	-0.102	Packhouse facility-rent	-0.127
Source of initial supply-mixed	0.073	Packhouse registration-no	-0.159
Procurement timing-late	-0.045	Shipments-moderate	0.746
Procurement timing-mid	-0.201	Shipments-high	0.760
Procurement timing-mixed	0.118		

Source: Author's estimations

Regression results of the impact of determinants on mango exports to the aggregate market are given in Table 5.9. The multiple R^2 for this model is obtained as 0.62. It indicates that the model explains approximately 62% of the variation in total mango exports in this market, while the adjusted R^2 is reduced to 0.56. The F-statistic is 10.05 (df = 14 and 85, p-value <0.001), indicating that the model as a whole is statistically significant. As discussed earlier, from the variables representing the exporters' characteristics, only the impact of exporters' education is observed in the OLS regression of this market. The non-significant coefficient of high education infers that it does not contribute significantly in increasing the mango export volume. It reveals that other factors such as logistics, market demand, and quality control may play crucial role in determining export success.

The inclusion of dummy variables to study role of firm's properties and its export activities in mango exports, only HWD treatment, moderate shipment, and high shipments are found with significant relationship with mango export, while the impact of wholesale as source of supply, mid-season procurement timing, and no packhouse registration are found insignificantly affecting mango exports in aggregate market. The negative coefficient of HWD infers that use of this treatment type may be associated with lower mango exports and the application of other treatment types i.e., HWT and VHT, instead of HWD, may result in more beneficial in regard of mango exports. Similar results regarding inefficiency of HWD were also discussed in a study by COLLINS et al., (2006) where it was observed that in order to control fruit fly, the Pakistani exporters are practicing the hot water dipping for less than 5 minutes, which has no scientific basis.

The moderate and high numbers of shipments with positive coefficients indicate that increased level of shipments has a substantial impact on mango exports, when compared to a reference category (low shipments). These results indicate that mango exporters who maintain a moderate or high number of shipments during the season are likely to experience greater levels of mango exports compared to those who have fewer shipments.

Cost-related determinants including purchase & production cost, international freight cost, clearing cost, and labor cost are found significant while the rest of the variables are insignificant. The positive coefficient of purchase & production cost suggests that purchasing or producing good quality mango is associated with higher mango exports. ANDREW (2007) also justified that adequate expenditures made at an early stage of production help in procuring quality mangoes with lower loss & damage. Additionally, as per COLLINS et al., (2006), there is a dire need of the investments in mango production systems in Pakistan as the low-quality production and marketing systems are one of factors causing the receipt of very low prices in high value market of the EU.

The negative coefficient of international freight cost implies that an increase in international freight cost will lead to a decrease in mango exports. This adverse effect is also elucidated in the study conducted by PADALIYA & PUNDIR (2022), where survey data revealed that exporters uniformly expressed concerns about the high freight costs. While sea transport is more cost-effective than air cargo, the lack of a developed sea protocol for perishables like mango, coupled with a significant increase in air freight rates in recent years incurred by exporters, serves as a constraint, limiting exporters from shipping a large quantity of mango. Moreover, the negative impact of clearing cost and labor cost indicates that increase in these costs is also associated with lesser mango exports.

Table 5.9: Determinants of total mango export in Aggregate market

Variables	Estimate	Std. error	t value	Pr.(>|t|)
Intercept	4.59	0.16	28.9	0.00***
Education-higher	0.24	0.26	0.92	0.36
Source of initial supply-wholesaler	-0.12	0.39	-0.28	0.77
Procurement timing-mid season	-0.34	0.55	-0.63	0.53
Treatment type-HWD	-0.66	0.32	-2.02	0.04**
Packhouse registration-no	-0.35	0.31	-1.17	0.24
Shipments-moderate	3.49	1.06	3.29	0.00***
Shipments-high	3.34	1.02	3.27	0.00***
Purchase & production cost (Rs/kg)	0.22	0.12	1.92	0.06*
Storage cost (Rs/kg/day)	-0.15	0.15	-1.03	0.30
Treatment cost (Rs/kg)	-0.03	0.12	-0.27	0.78
Cooling cost (Rs/kg)	0.05	0.13	0.40	0.69
Packing cost (Rs/kg)	0.03	0.12	0.22	0.82
Clearing agent cost (Rs/kg)	-0.19	0.10	-1.83	0.07*
International freight cost (Rs/kg)	-0.36	0.13	-2.85	0.00***
Labor cost (Rs/kg)	-0.52	0.11	-4.75	0.00***

Note: *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively.
Source: Author's estimations

b) Regression analysis of Specialized–EU exports

In the pursuit of understanding total mango exports to Specialized–EU market, the ridge analysis has been conducted first to identify the socio-economic and dummy determinants of total mango export of 44 firms in this market. This step ensured the validity and reliability of the OLS regression estimates. The results from ridge regression are presented in Table 5.10. For the ridge weights of socio-economic variables of exporters, none of the variables is found exerting substantial influence on mango exports to this market. It indicates that other factors i.e., costs and export-related decisions may have more influence than exporters' socio-economic characteristics. Hence, these variables will not be studied in OLS regression for this market.

Moreover, from dummy variables representing the firm's business activities, few influential factors has been highlighted with notable impact, including the source of initial supply-farmer, procurement timing-mid, mixed approach of GAP certification, exporter type-grower-cum, treatment type-VHT, packhouse registration-no, and shipments-high. Empirical investigation of these important determinants w.r.t to total mango exports in this market is presented in OLS regression estimates.

Table 5.10: Weights of determinants of total mango export in Specialized–EU market

Determinants	Ridge coefficients	Determinants	Ridge coefficients
Intercept	47.95	GAP certification-no	-0.010
Age (year)	0.000	GAP certification-mixed	0.022
Education-secondary	-0.002	Exporter type-grower-cum exporter	0.018
Education-higher	0.020	Exporter category-group exporter	0.003
Experience (year)	-0.0001	Treatment type-HWD	0.016
Source of initial supply-farmer	-0.025	Treatment type-VHT	-0.039
Source of initial supply-contractor	0.001	Treatment plant facility-no	-0.004
Source of initial supply-wholesaler	-0.0002	Packhouse facility-rent	0.014
Source of initial supply-mixed	0.012	Packhouse registration-no	0.0078
Procurement timing-mid	-0.018	Shipments-moderate	0.0009
Procurement timing-late	0.003	Shipments-high	-0.026
Procurement timing-mixed	-0.004		

Source: Author's estimations

Table 5.11 represents the estimated results of OLS regression for the determinants selected from ridge regression as well as important cost factors in Specialized–EU mango exports. The multiple R^2 value for this model is 0.51, which indicates that approximately 51% of the variance in total mango export can be explained by the variables included in the model while the adjusted R^2 is 0.38. The F-statistic is 3.86 (p-value = 0.002), indicating that the model, as a whole, is statistically significant. As all the socio-economic variables of exporters were observed having negligible impact on mango exports in Specialized–EU market from ridge coefficients, these variables are not discussed further in OLS regression. Moreover, the influence of variables for firm's export related activities are estimated, which resulted in significant contribution of farmer as source of initial supply and mid-season procurement timing in mango exports while non-significant association of absence of treatment plant facility is found.

The negative coefficient of farmer being the source of initial supply indicates that firms that primarily source their mangoes from farmers experience significantly lower mango exports as compared to other sources such as wholesalers, retailers etc. This may be due to potential challenges related to consistent supply and quality when sourcing from multiple farmers. Moreover, it was also reported by MALIK (2006) that 90% of the orchards are marketed by contractors which results in farmers being unaware of individual plant needs, resulting in post-harvest losses.

Another possible reason of this damping impact was given by COLLINS et al., (2006), where the poor mango tree management practices by farmers was reported. Moreover, firms which make mango purchases during the mid-season, exhibit lower mango exports as indicated by negative coefficient. This could be attributed to increased competition or quality fluctuations during the mid-season.

Lastly, the impact of cost related variables; purchase & production cost, domestic transport cost, storage cost, freight forwarder cost, international freight cost, and other costs are discussed for Specialized–EU mango exports. Among these variables, domestic transport cost, storage cost, freight forwarder and international freight costs are observed with significant impact on mango exports while the rest are found with non-significant influence. The positive coefficient of domestic transportation cost indicates that investment in transportation services may result in high mango exports. COLLINS et al., (2006) supported this argument, noting that approximately 60% of roads in Pakistan, especially in rural areas, are unsealed and in poor condition. Trucks with basic suspension systems may contribute to reduce injuries to the fruit. Additionally, loads are often unrefrigerated and uncovered, leading to a shorter shelf life as top-layer boxes easily overheat. MALIK (2006) also reported that improper handling and transportation techniques are one of the postharvest supply chain issues that need attention. Domestic transport for perishable commodities was highlighted as a concern by ANDREW (2007), as produce can be damaged in transit due to the constant shaking on bumpy roads.

The coefficient of storage cost indicates a positive impact on mango exports. This suggests that careful management of mango by investing in storage facilities to maintain its quality may contribute to increased exports. The importance of investing in storage house was also highlighted by COLLINS et al., (2006), as Pakistan's export market is encountering challenges with fruits that have a very short shelf life, the absence of cool chain management and insufficient storage capacity are contributing factors in these challenges.

While, the negative coefficient of freight forwarding cost suggests that firms may need to find a balance between cost-effective freight forwarding and export quantities. Similar to aggregate market, negative coefficient of international freight cost is observed in this market as well, indicating its damping impact on mango exports. This adverse effect was also discussed by KATO et al., (2014) while investigating international sea freighting between Southeast Asia and the U.S. They reported that there has been a noticeable shift from air freight to maritime freight in recent years, primarily attributed to increases in fuel costs and advancements in container and shipping technology. Hence, the importance of managing transport costs to remain competitive in the high value markets should be considered.

Table 5.11: Determinants of total mango export in Specialized–EU market

Variables	Estimate	Std. error	t value	Pr.(>|t|)
Intercept	76.25	9.09	8.38	0.00***
Source of initial supply-farmer	-14.80	4.00	-3.69	0.00***
Procurement timing-mid	-20.43	7.99	-2.58	0.014**
Treatment plant facility-no	5.06	5.30	0.95	0.34
Purchase & production cost (Rs/kg)	0.06	0.17	0.37	0.71
Domestic transport cost (Rs/kg)	1.37	0.50	2.72	0.01**
Storage cost (Rs/kg/day)	1.17	0.63	1.86	0.07*
Treatment cost (Rs/kg)	-0.02	0.22	-0.09	0.92
Freight forwarder cost (Rs/kg)	-2.35	1.25	-1.87	0.06*
International freight cost (Rs/kg)	-0.22	0.08	-2.78	0.00***
Labor cost (Rs/kg)	-0.05	0.14	-0.36	0.71
Other costs (Rs/kg)	1.69	1.73	0.97	0.33

Note: *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively.
Source: Authors' estimations

c) <u>Regression analysis of Diversified-EU exports</u>

Similar to previous markets, mango exports to Diversified–EU market with 56 firms is also investigated with a comprehensive set of socio-economic, dummy and cost-related variables. These factors have also undergone transformations of scaling and ridge regression. The ridge regression results for socio-economic and dummy variables to determine the mango exports to Diversified–EU market are given in Table 5.12. It reveals crucial points about the impact of various explanatory variables on mango export.

Notably, among socio-economic variables, only education-secondary resulted in substantial positive coefficient, suggesting that an increase in educational level affect mango exports to this market. Hence, this variable will be further observed in OLS regression. Conversely, for factors representing firms' business activities, few variables have shown impact on mango exports in Diversified–EU market. Variables selected for the final OLS regression include number of education-secondary, source of initial supply-wholesaler, and shipments-high, which indicate their signified role in influencing mango exports to Diversified–EU market. These variables are likely to play a substantial part in determining the volume of mango exports, with the potential of both positive and negative effects.

Table 5.12: Weights of determinants of total mango export in Diversified–EU market

Determinants	Ridge coefficients	Determinants	Ridge coefficients
Intercept	45.80	GAP certification-no	-0.013
Age (year)	0.001	GAP certification-mixed	0.007
Education-secondary	0.027	Exporter type- grower-cum exporter	0.004
Education-higher	-0.006	Exporter category- group exporter	-0.009
Experience (year)	0.000	Treatment type-HWD	0.028
Source of initial supply-farmer	0.014	Treatment type-VHT	-0.020
Source of initial supply-contractor	-0.010	Treatment plant facility-no	-0.018
Source of initial supply-wholesaler	-0.018	Packhouse facility-rent	-0.018
Source of initial supply-mixed	-0.001	Packhouse registration-no	-0.007
Procurement timing-mid	0.006	Shipments-moderate	0.034
Procurement timing-late	-0.020	Shipments-high	0.013
Procurement timing-mixed	0.0028		

Source: Author's estimations

After the utilization of ridge regression, the OLS regression results of variables influencing mango exports to Diversified–EU market are given in Table 5.13. This model exhibits a reasonably moderate fit to the data, with an adjusted R^2 of 0.57, indicating that approximately 57% of the variance in mango exports is explained by the variables included in the model. The F-statistic of 8.20 (df= 10 & 45 and p-value <0.001) is statistically significant, indicating that the model as a whole is meaningful in explaining mango export.

Out of the variables linked with the firm owner's characteristics, education impact on mango export is discussed in this regression. It is found that education of exporters holds a positive significant on exports. It aligns with the economic reasoning as an educated individual is perceived to handle business activities more effectively. GHAFOOR et al., (2010) also justified significant positive relation between education and better performance of mango export business.

Among the variables representing the qualitative characteristics of firms export activities, source of initial supply as wholesaler (in comparison with other sources provided in Table 5.6) and high number of shipments (in comparison with low and moderate) are found to have significant impact on mango exports, whereas non-significant impact of treatment type as HWD (in comparison with HWT and VHT) highlights that it does not strongly influence mango exports. The source of initial supply-wholesaler has a positive effect on exports, indicating that sourcing product from wholesalers positively affects mango exports in this market. In a review of production and marketing of mango fruit, CHAY et al., (2019) also recognized wholesalers in their ability to acquire bulk quantities of products, backed by strong financial and informational capabilities than farmers. In a case study of constraint analysis of Pakistan mango supply chains, COLLINS et al., (2006) also observed that mangoes are typically acquired from the wholesale market at regular wholesale prices as opposed to directly from farmers in Pakistan.

The high number of shipments also has a positive influence on exports. It infers that shipments categorized as high per season, in comparison with low and moderate shipments, lead to increased mango exports. A similar finding was elucidated for the aggregate exports. Whereas, for the cost related variables affecting the export volume, all variables indicated significant influence, except for treatment verification cost, purchase & production cost, international freight cost, and labor cost. Similar to Specialized–EU exports, the positive coefficient of domestic transport cost is also observed in Diversified–EU exports. It infers that it positively contributes to high mango exports, and it can be suggested that quality use of domestic transportation services within the country may associate with increased exports. As per MALIK (2006), improper transport conditions were highlighted as a factor causing post-harvest losses and, consequently, leading to a reduction in mango exports. Storage cost negatively affects mango exports, implying that higher storage costs are associated with decreased export quantities.

Moreover, the cooling cost is found to have a negative impact, depicting that higher cooling costs may reduce export volumes. The packing cost influences mango exports positively, suggesting that the use of better quality packing material and efficient management of packing is positively associated with higher export quantities. As emphasized by MALIK (2006), inadequate packing and packaging materials constitute one of the factors contributing to post-harvest losses in mangoes. It is suggested that investment is needed to improve packing material and practices for mango exports. Additionally, COLLINS et al., (2006) also highlighted the issue of packaging, pointing out a lack of consistency in terms of good quality packaging among mango exporters in Pakistan. Lastly, the negative coefficient of freight forwarder cost indicates that high freight forwarder cost is associated with decrease on export volume of mango from Pakistan to Diversified–EU market.

Table 5.13: Determinants of total mango export in Diversified-EU market

Variables	Estimate	Std. error	t value	Pr. (>|t|)
Intercept	12.84	5.91	2.17	0.03*
Education-secondary	14.28	2.69	5.29	0.00***
Source of initial supply-wholesaler	11.05	4.05	2.72	0.00***
Treatment type-HWD	6.22	3.96	1.57	0.12
Shipments-high	26.23	8.95	2.92	0.00***
Purchase & production cost (Rs/kg)	-0.009	0.12	-0.78	0.93
Domestic transport cost (Rs/kg)	1.04	0.36	2.76	0.00***
Storage cost (Rs/kg/day)	-2.58	1.02	-2.57	0.013**
Treatment verification cost (Rs/kg)	1.48	0.84	1.50	0.14
Cooling cost (Rs/kg)	-5.07	1.15	-4.04	0.00***
Packing cost (Rs/kg)	1.63	0.39	4.28	0.00***
Freight forwarder cost (Rs/kg)	-1.78	0.85	-2.09	0.06**
International freight cost (Rs/kg)	-0.02	0.10	-0.18	0.85
Labor cost (Rs/kg)	-0.01	0.20	-0.07	0.94

Note: *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively.
Source: Author's estimations

5.5 Summary and conclusion

The computation of export margins and OLS regression analysis of determinants of mango exports to different markets provided critical insights into the profitability and financial intricacies of mango exports from Pakistan. In the aggregate market, the final export cost was calculated as 2.34 USD/kg, with international freight cost and purchase & production cost emerging as dominant contributors. The significant impact of these two major costs on export volumes, ultimately on net margin, was also observed in OLS regression. The net export margin obtained from this export market was found 2.29 USD/kg, which indicted reasonable profit, albeit with potential risks related to variable costs. Apart from international freight cost and purchase & production cost, the OLS regression also indicated the positive impact of moderate and high number of shipments, lower clearing agent cost, and labor cost on mango exports. However, the education level of exporters and rest of the cost-related variables observed in export margins were found insignificant.

In the Specialized–EU exports, the final export cost was observed as 2.44 USD/kg, driven by substantial international freight cost. The net export margin of 2.78 USD/kg indicated the highest profitability among all the analyzed markets. OLS regression also confirmed the negative impact of international freight cost on export volumes indicating that high freight costs hinders exports ultimately affecting net margin. In addition, among firm's characteristics and cost factors, farmer being the initial supply source, mid-season procurement timings, and freight forwarder cost were also found negatively affecting mango exports.

The Diversified–EU market exhibited the final export cost 2.52 USD/kg, with international freight cost and purchase & production cost being significant factors. The net export margin for this market was observed as 2.65 USD/kg, reflecting this market's potential for higher profits. The OLS regression also revealed the significant impact of several factors. For instance, exporters with secondary education level are able to achieve higher export volumes per season than less educated exporters. The use of quality packing material also positively influenced the total mango quantity exported, as did the product sourcing from wholesalers and managing domestic transportation services effectively. However, higher cooling costs and storage costs negatively impacted the export in this market.

In conclusion, across various markets, the number of shipments, education levels of exporters, and effective cost management emerge as recurring influential factors. Specifically, maintaining a moderate to high number of shipments per season consistently lead to increased mango exports, underlining the importance of export scale or alternatively shipment size. Higher education levels among exporters contribute positively to export volumes, although this effect varies by market. Effective management of cost-related variables, such as storage, domestic transportation, and packing can significantly boost export volumes. These findings emphasize the need for tailored strategies when exporting to different markets, recognizing the specific factors that play significant roles in each market, separately.

6 TRANSPORT MODE CHOICE

In this chapter, the anticipated demand of Pakistan mango exporters for air and sea transport services to the European Union and their Willingness-to-Pay (WTP) for improvements in these services is discussed. Stated choice experiment (discrete choice modeling) is adopted to investigate determinants of transport mode choice for exports to European countries. Given that, the Conditional Logit model (with main effects) and Mixed Logit model (with random effects) are used for the empirical estimations. Willingness-to-pay estimates in the context of exporters' welfare for shipping services are computed through the Wald procedure (Delta method). The research methodology employed in this study is based on the theoretical framework of consumers' choice behavior developed by LANCASTER (1966) implying that goods are not the direct objects of utility, rather it is characteristics of the goods from which utility is derived. The analysis identifies heterogeneity in the preferences of exporters, elucidating that exporters' decisions are predominantly influenced by factors such as transport cost, transit time, loss & damage, frequency, and insurance.

6.1 Introduction

The agro-food trade among low and high-income countries has experienced substantial growth in recent decades. International food trading is progressively influenced by its quality standards and modes of transportation (SWINNEN & MAERTENS, 2007). Over the last two decades, the diminishing costs associated with cross-border transactions have propelled the international trade of goods and services, commonly referred as the "era of globalization". This period witnessed a notable surge in cross-border transactions, facilitating investments in international trade infrastructure and subsequently contributing to a reduction in transportation costs. However, a significant aspect often overlooked in many empirical studies is the decrease in transport costs, and its subsequent impact on amplification of trade volumes (HAFNER et al., 2023).

Trade costs represent a significant potential impediment to international trade in Pakistan and hinder the actualization of benefits derived from trade liberalization. Consequently, there is a heightened emphasis on understanding and addressing trade costs. The gradual reduction of trade costs has emerged as a transformative force, leading to a substantial increase in international trade. This notable shift has resulted in improvements across countries, fostering enhanced opportunities for international trading in recent years (MAHMOOD et al., 2017).

The principal factors influencing trade costs in Pakistan encompass a spectrum of various determinants, key among these is logistics cost which includes both freight cost and time-related expenses. Other contributing factors involve information costs, contract enforcement costs, tariff & non-tariff measures, currency exchange rate, and necessary regulatory costs. The current trade volume of Pakistan does not adequately represent its actual trade potential. This discrepancy is primarily attributed to the persistent nature of Pakistan's foreign trade direction, which remains heavily influenced by trade costs and has seen minimal reduction since the country's independence. To fully capitalize on its international trade opportunities, Pakistan needs to gain a comprehensive understanding of the factors influencing trade costs. Prioritizing a detailed examination of these determinants is crucial for Pakistan, as it will enable the country to enhance its capabilities and position itself more effectively within global networks of production and trade. By addressing its trade costs, Pakistan can potentially gain competitiveness in international trade.

Despite global trade competition leading to a decline in international logistics costs, Pakistan experiences comparatively higher costs in this domain within the region. This discrepancy can be associated with various inadequacies present in the country's infrastructure and logistics systems (MOPD, 2019). The elevated shipping costs for Pakistan adversely impact the competitiveness of exporting firms in international markets. As shipping costs rise, businesses in Pakistan face increased expenses for exporting goods and diminished returns for their exports.

Within the context of competitive global markets, higher transport costs necessitate counterbalancing measures, such as lower wages or reduced costs at other stages of the export process, to enable firms to remain competitive. This challenge is particularly critical in labor-intensive manufactured export activities characterized by low-profit margins. In such scenarios, even minor disparities in shipping costs can determine the distinction between profitability and losses in export endeavors. This intricate relationship between shipping costs and firms' competitiveness gets even more challenging in exports of fruits like mango at the global marketplace.

In the context of Pakistan's mango export to the EU market, the export profitability hinges on logistical considerations (Figure 6.1). The logistics encompass various inland export-related activities including mango sourcing, transporting to processing firms, treatment applications, packing, and delivering shipments. Additionally, international logistics costs, primarily freight charges, constitute a substantial portion, accounting for approximately 70% of the total export cost. A noteworthy insight is that a reduction in this cost-share can significantly enhance exporters' profitability, positioning Pakistan as a competitive country in the EU market alongside other major mango exporters like Brazil and Peru. Crucial to optimize mango freight charges for the EU market is the strategic determination of the export mode by the exporters; whether by air or by sea. In this dynamic, exporters prioritize selecting the most cost-effective mode, be it air or sea, to maximize profitability and gain a competitive edge in the EU market.

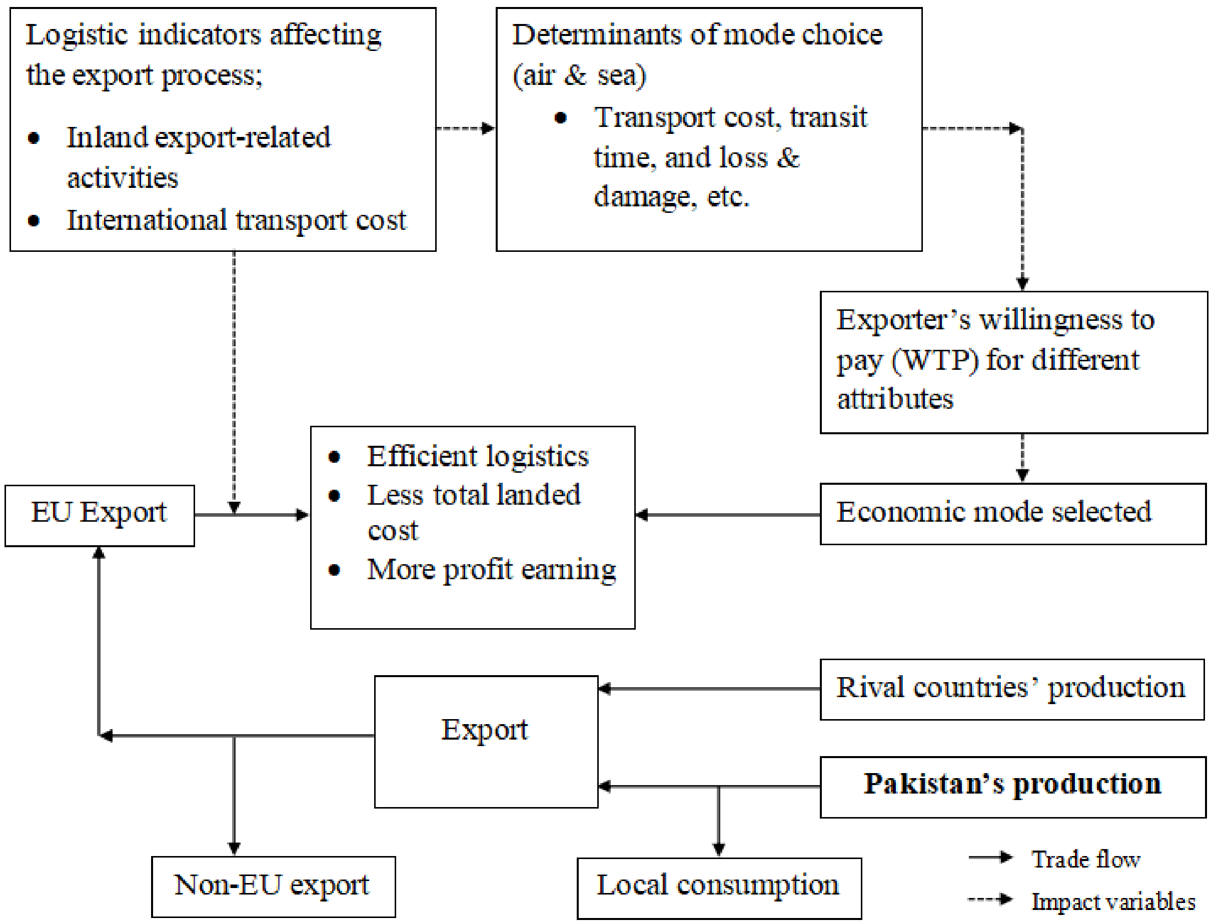

Figure 6.1: Framework of Pakistan's mango export to the European market

Source: Author's illustration

To explore the selection of an economic transport mode based on its determinants, the preferences of mango exporters regarding the choice of transport mode (air or sea) for the EU market are investigated. Continuing with the exploration of possible factors affecting mode choice, Likert scale method is employed to record exporters' perceptions of transport limitations encountered in the export (Figure 6.2). Exporters perceive air transport costs as notably high (4.15), while sea transport costs are relatively low (0.38). Air transport is perceived to have a lower transit time (0.79), whereas sea transport incurs a higher transit time (3.5). For loss & damage, air transport is associated with minimal concerns (0.78), while sea transport faces higher perceived risks (4.15). Meanwhile, for freight capacity, air transport is perceived to have a higher value (2.79), while sea transport has a relatively lower capacity (0.29).

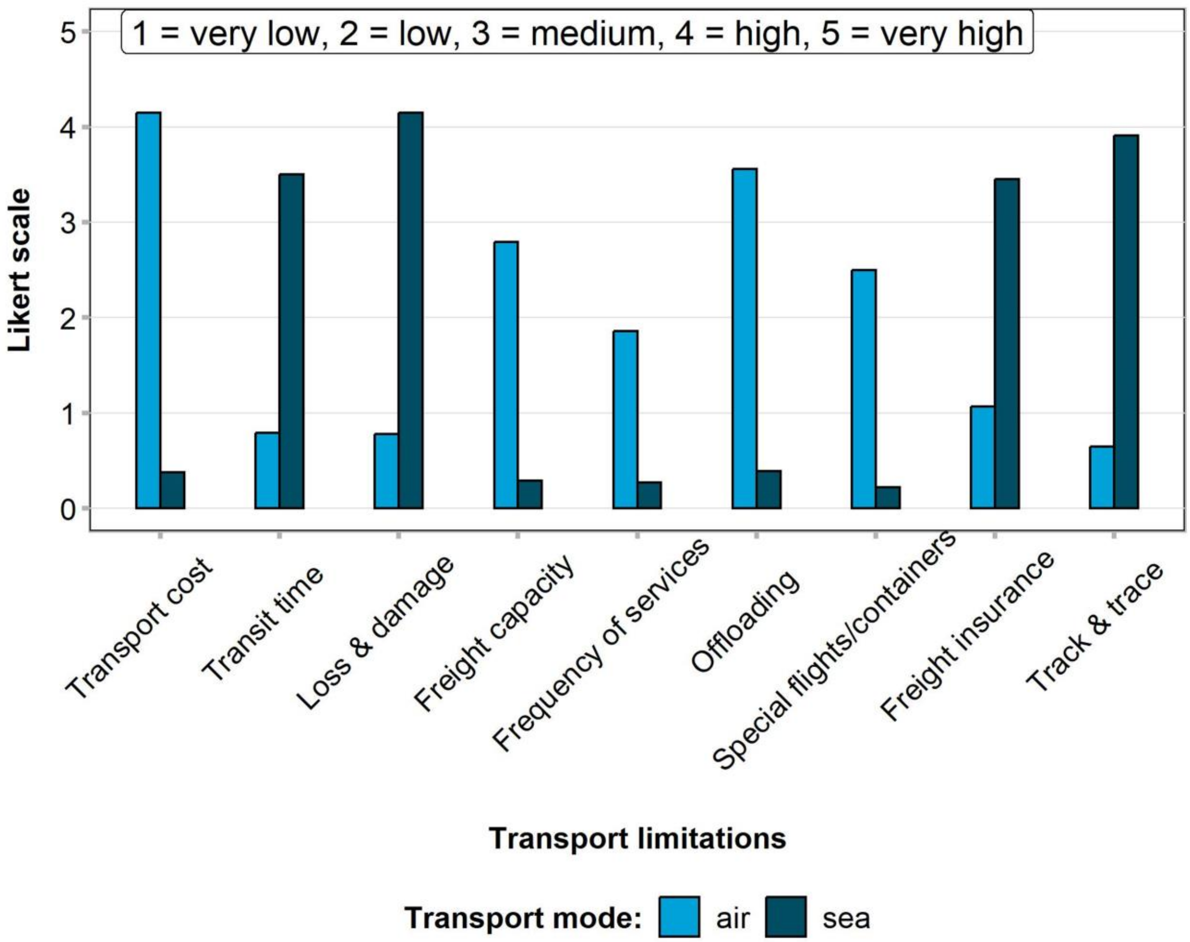

Figure 6.2: Exporters' perception of transport limitations affecting mode choice

Source: Author's illustration based on survey data (2014)

Regarding frequency, exporters are more concerned about air transport (1.86), compared to sea transport (0.27). In air transport, exporters perceive high chances of offloading (3.56) as a serious issue, whereas sea transport incurs minimum offloading chances (0.39). For special flights/containers, air transport is associated with more flights (2.5) according to exporters, while sea transport has fewer specialized containers (0.22). Exporters perceive air transport as having lower freight insurance concerns (1.07), while sea transport is associated with higher perceived insurance issues (3.45). Lastly, shipment track and trace are not perceived as a serious issue in air transport (0.65), while in sea transport it is expressed as a challenging factor (3.91). Among these entire potential mode choice attributes, transport cost, transit time, loss & damage, frequency of services, and freight insurance were identified as the most crucial factors by exporters. The selection of these attributes stems from careful consideration of exporters' perspectives on the importance of each factor in determining their choice of transport mode for exporting mangoes to EU countries.

In analyzing the key determinants of mango export from Pakistan to the EU market, two pivotal factors are transit time and freight charges. Figure 6.3 reveals a notable discrepancy between air and sea modes. On average, air transportation expedites the shipping process, requiring only half a day, while sea transportation extends over a lengthy period, averaging 28 days. This underscores the trade-off between time and cost in the choice of export mode by exporters in Pakistan. While, exporting by air commands higher transport costs, with an average of 1.9 USD/kg[24]. In contrast, sea transportation, being more economical, incurs an average freight charge of 0.3 USD/kg only. This explains the significant considerations; exporters weigh in while selecting a transport mode, emphasizing the nuanced relationship between transit time and freight charges in optimizing profitability.

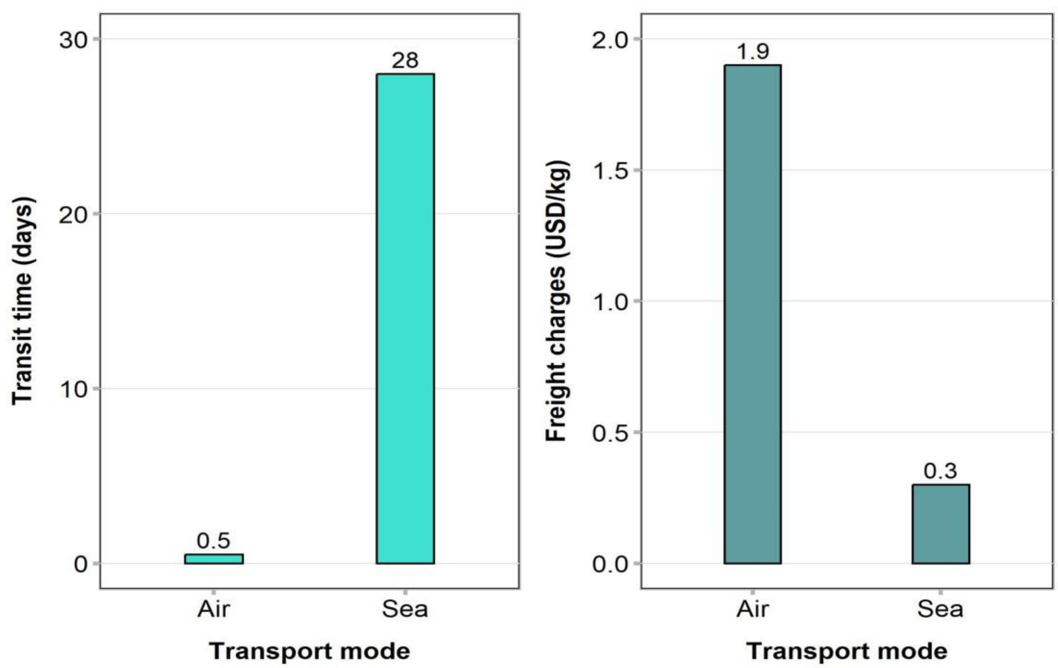

Figure 6.3: Transit time and freight charges from Pakistan to the Europe (2014)

Source: Author's illustration based on survey data (2014)

[24] Exchange rate: 1 USD = 100 Rs (2014)

6.2 Choice modeling theory

There are several different ways in which one could classify freight demand models. In general, they are classified as aggregate (i.e., the basic unit of observation is an aggregate share of a particular freight mode at the regional or national level) and disaggregate models (i.e., the basic unit of observation is an individual decision taker's choice of a particular freight mode for a given shipment). The aggregate models have tended to be based on cost-minimization behavior of firms while the disaggregate models have attempted to be more specific to the behavioral realities of freight transportation decision-making. Therefore, it could be argued that in particular contexts, the disaggregate models are more attractive models from a theoretical point of view (see Figure 6.4).

THURSTONE (1927) laid the ground for random utility models by deriving the effect of good's characteristics (or attributes) on consumers' preferences, meaning their choice probabilities. MCFADDEN (1974), formalized the random utility maximization (RUM) approach and developed a statistical model, based on which LOUVIERE & WOODWORTH (1983) conducted the first Choice Experiment (CE). The discrete choice experiment (DCE) stands out as a widely adopted method for uncovering individual preferences, offering researchers the flexibility to discern respondents' preferences among a set of program or policy attributes (TOIBA et al., 2023). Its foundation rests on a robust and transparent framework, incorporating the random utility theory (MCFADDEN, 1973; LOUVIERE et al., 2010) and consumer theory (LANCASTER, 2001).

These theories posit that a program consists of various inherent attributes and the evaluation by program participants is grounded in these attributes rather than the program itself. DCE proves essential for conducting feasibility analyses of new programs or policies that are either non-existent in the real world or lack supporting data (NOOR et al., 2022). The method excels in identifying the average relative importance of attributes within a program or policy, enabling the calculation of trade-offs made by respondents. This capability positions DCE as a valuable tool for understanding preferences and conducting nuanced analyses in the absence of real-world implementation or existing data.

During the data collection process, to facilitate respondents' understanding of the decision-making in the choice experiment, a meticulously designed choice card with clear explanations is deemed essential. The choice cards are randomly presented to respondents with several alternatives and asked to make their preferences among the given choice options. While stating their preferences, decision makers have the flexibility to adjust trade-offs among choice attributes. This adaptive process mirrors real-world decision-making, rendering the use of DCE in evaluating respondents' preferences highly effective (TRAPERO-BERTRAN et al., 2019). DCE, distinguished among other stated preference methods, has garnered popularity due to its capacity to provide respondents with realistic choices, a crucial element for making well-informed decisions (MARIEL et al., 2021). The DCE questionnaire (choice cards), known for its ease of comprehension by respondents, also allows researchers to calculate the marginal values of willingness-to-pay (WTP) for specific attribute levels (ABRATE et al., 2016; CANTILLO et al., 2020).

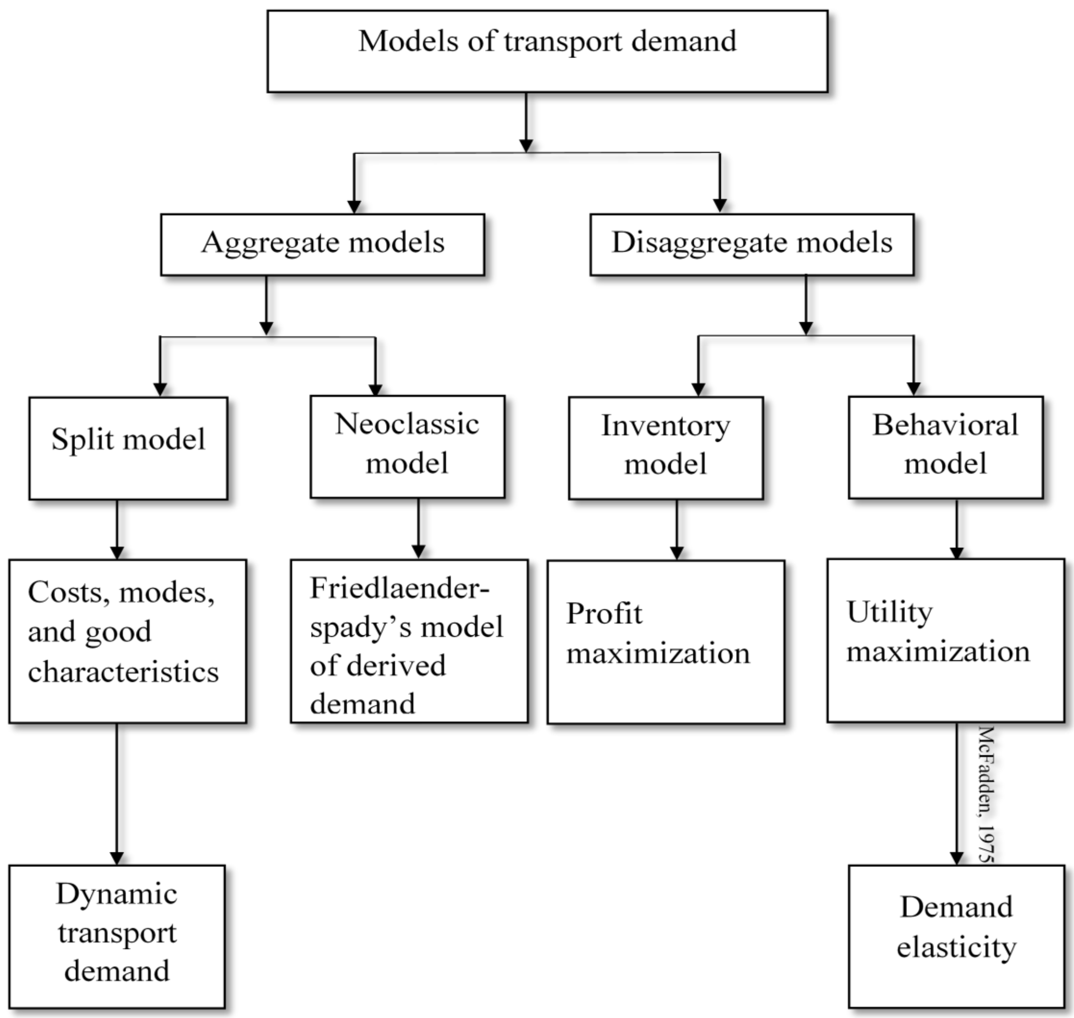

Figure 6.4: Summary of freight transportation demand models

Source: Derived from WINSTON, C. (1983)

For Pakistan's mango exports to the EU market, this theoretical foundation provides a conceptual basis for analyzing and interpreting the preferences expressed by the exporters. Pakistan mango exporters are assumed to elicit their mode choices based on transport and other trade-related attributes.

6.2.1 Conditional logit model

The discrete choice experiment is usually modeled under the assumption of utility maximization behavior by the decision maker. Therefore, the modeling focus in this study is on the mango exporter's selection of a transport mode aimed at maximizing net profit. This choice involves considering various levels of export-related attributes such as transport cost, transit time, and others. For each exporter i, the selection of j transport mode is made out of k alternatives within a choice set C, each associated with distinct levels of utility. The utility function (U_{ij}) comprises of deterministic component (V_{ij}) and a stochastic component (ε_{ij}).

$$U_{ij} = V_{ij} + \varepsilon_{ij} \quad (6.1)$$

Exporter i will choose a specific transport mode j (out of k) if and only if $U_{ij} > U_{ik} \, \forall \, j \neq k.$ According to MCFADDEN (1973) and BEN-AKIVA & LERMAN (1985), the probability of choosing an alternative with maximum utility is given as,

$$P_{ij} = Pr(U_{ij} \geq U_{ik}) \quad (6.2)$$

Substituting the random utility model from equation (6.1),

$$P_{ij} = Pr(V_{ij} + \varepsilon_{ij} \geq V_{ik} + \varepsilon_{ik}) \quad (6.3)$$

$$P_{ij} = Pr(V_{ij} - V_{ik} \geq \varepsilon_{ij} - \varepsilon_{ik}) \quad (6.4)$$

In equation (6.2), P_{ij} represents the probability of choosing from alternatives, U_{ij} as the random variables representing utility for individual i choosing alternative j, whereas, in equation (6.3), V_{ij} as the systematic components of U_{ij}, ε_{ij} as the disturbance component (unobserved utility) of U_{ij}. Assuming that ε_{ij} in equation (6.4) is independently and identically distributed with a Type-I extreme value distribution and a fixed variance, the probability (P_{ij}) of choosing j can be represented using the following logit function:

$$P_{ij} = \frac{exp(V_{ij})}{\sum_{k=1}^{k} exp(V_{ik})} \; ; j \in k \tag{6.5}$$

This can be estimated with a Conditional Logit (CL) model (MADDALA, 1983; LOUVIERE et al., 2000) as follows,

$$V_{ij} = \beta_0 + \beta_1 X_{ij1} + \cdots + \beta_n X_{ijn} + \varepsilon_{ij} \tag{6.6}$$

This is the main effect model in which V_{ij} is the observed utility derived from alternative j by decision maker i, and $\{X_{ij1}, ..., X_{ijn}\}$ are the relevant attributes (n) of the transport mode. The coefficients $\{\beta_0, ..., \beta_n\}$ are parameters to be estimated through the CL model, capturing the impact of each attribute on the utility of the transport mode. Lastly, the probability P_{ij} reflects the likelihood of choosing alternative j from the set of options available.

The Conditional Logit (CL) model relies on the assumption of the Independence of Irrelevant Alternatives (IIA), which implies that the relative probabilities of choosing from four alternatives remain unaffected by the introduction or removal of other alternatives from the choice set. Violation of the IIA property can introduce biasness into the results of the CL model (LOUVIERE et al., 2000; ROLFE et al., 2000). Another limitation of the CL model is the assumption of homogeneous preferences across exporters. Less restrictive alternatives to the CL model include the random parameter logit or latent class models (HENSHER et al., 2006).

According to GARCÍA-MENÉNDEZ et al., (2004), the interpretation of coefficients in a conditional logit model differs explicitly from other models, such as binary choice logit. In a conditional logit model, coefficients corresponding to attributes of the dependent variable are not directly associated with marginal effects, and consequently, they do not provide insight into the switch ratios that researchers typically seek. In this model, each set of attributes X_i influences all the probabilities of the various alternatives of the dependent variable. It is important to note that here coefficients are referred to attributes' coefficients, not the characteristics of the decision-maker or the attributes of variables that remain constant regardless of the chosen mode. Individuals' preferences for these attributes can be quantified by estimating their willingness-to-pay values.

6.2.2 Mixed logit model

Due to the limitations of the CL model discussed in previous section, an alternative approach is to use the Mixed Logit model which allows incorporating interactions of exporters' characteristics with various export attributes in the utility function (ADAMOWICZ et al., 1997). These interaction terms can capture exporters' heterogeneous preferences, thereby improving the accuracy and reliability of the estimates (GREENE, 1997). To address IIA violations, the inclusion of socioeconomic variables is also suggested, as characteristics relevant to exporter preferences can increase the deterministic component of utility while reducing the stochastic one (BATEMAN et al., 2003; ROLFE et al., 2000). With interaction terms in the ML model, the indirect utility function is specified as follows (ROLFE et al., 2000),

$$V_{ij} = \beta_0 + \beta_1 X_{ij1} + \cdots + \beta_n X_{ijn} + \delta_1 X_{ij1} S_{i1} + \cdots + \delta_l X_{ijn} S_{im} + \varepsilon_{ij} \qquad (6.7)$$

Here, m represents the number of exporter-specific socioeconomic characteristics, and S (where $S = S_1$ to S_m) is the vector encompassing these characteristics. Additionally, $\delta_1$to δ_l constitute the l-dimensional matrix of coefficients associated with the interaction terms, capturing the influence of these terms on the utility function. The model given in equation (6.8) is estimated as mixed logit model with interaction terms. A prevalent method to justify the mixed logit model is through the random utility model with individual-specific coefficients. This implies that the utility derived by decision maker i from alternative j is expressed as a linear combination of β_i and x_{ij}, incorporating the stochastic component ε_{ij}.

$$U_{ij} = \beta_i{}' x_{ij} + \varepsilon_{ij} \qquad (6.8)$$

In equation (6.8), x_{ij} represents the data for alternative j and decision maker i, β_i represents the individual-specific vector of coefficients, and ε_{ij} is the i.i.d extreme value error term. In this model, the choice becomes deterministic as preferences (β_i) and unobserved utility (ε_{ij}) are known by the decision maker. That is, decision maker i chooses alternative j if and only if,

$$U_{ij} > U_{ik} \, \forall \, j \neq k \qquad (6.9)$$

In the CL model, an underlying distribution is established by assuming the joint density of unobserved utility (ε_{ij}), and subsequently, choice probabilities are derived from this density function. Conversely, in the ML model, a reverse condition occurs. The mixed logit model, being any discrete choice model with choice probabilities

(P_{ij}) in the specific form, outlined in equation (6.10), allows for the direct definition of the model based on these choice probabilities. This stands in contrast to the logit model, where the model is typically defined by assuming the unobserved utility and then deriving the choice probabilities from that assumption.

$$P_{ij} = \int L_{ij}(\beta)\, f(\beta \mid \theta)\, d\beta \tag{6.10}$$

It can be deduced that choice probability (P_{ij}) of a decision maker i choosing alternative j, is equal to the integral of logit choice probability at a given set of coefficients $L_{ij}(\beta)$ over the density of coefficients $f(\beta \mid \theta)$, which depends upon the vector of parameters θ. From equation (6.10), $L_{ij}(\beta)$ is defined as,

$$L_{ij}(\beta) = \frac{e^{V_{ij}(\beta)}}{\sum_{k=1}^{k} e^{V_{ik}(\beta)}} \tag{6.11}$$

Therefore, equation (6.10) can be written as,

$$P_{ij} = \int \frac{e^{V_{ij}(\beta)}}{\sum_{k=1}^{k} e^{V_{ik}(\beta)}}\, f(\beta \mid \theta)\, d\beta \tag{6.12}$$

It is important to mention here that the choice probabilities of the mixed logit model don't have closed-form expression and are approximated with the use of simulations. Hence, it can be summarized that the mixed choice probability is the weighted average of logit choice probabilities $L_{ij}(\beta)$, evaluated at different values of β, and each logit choice probability is weighted by the density $f(\beta|\theta)$. The mixed logit model becomes more robust by the addition of β_i but at the same time, it becomes challenging to observe preferences (β_i) for each individual. For its solution, β_i is modeled as a random variable with a density $f(\beta|\theta)$. Hence, with the unknown β_i, the integral from equation (6.12) is integrated over the random coefficients to obtain the unconditional choice probabilities, given as,

$$P_{ij} = \int \frac{e^{(\beta' x_{ij})}}{\sum_{k=1}^{k} e^{(\beta' x_{ik})}}\, f(\beta \mid \theta)\, d\beta \tag{6.13}$$

Which is again the weighted average over all possible logit choice probabilities with the density of coefficients (β).

6.2.3 Willingness to pay

In economics, the willingness-to-pay (WTP) refers to the monetary amount that an economic agent is willing to spend to acquire a desired good or service (level), or conversely, willing to pay as compensation for parting with or enduring something desirable (GATTA et al., 2014). It reflects the subjective value or utility that individuals attach to goods, services, or outcomes. WTP, a crucial indicator of an individual's preferences, is computed on the basis of discrete choice model estimations. WTP measures can be directly derived from the model's coefficients using the following formula given by MASIEROA et al., (2015),

$$WTP_j = \frac{MU_j}{MU_{cost}} = \frac{\beta_j}{\beta_c} \tag{6.14}$$

Here, WTP_j represents the willingness to pay for the attribute j, MU_j is the marginal utility associated with that attribute, and MU_{cost} is the marginal utility of monetary attribute i.e., cost or price. Since the model estimation provides estimates of the true coefficients, the calculated willingness to pay (WTP) is also an estimate derived from a particular probability distribution. In cases where the sample size is sufficiently large, the maximum likelihood estimates of the coefficients in the model exhibit asymptotically normal distribution. Consequently, for large samples, it is reasonably assumed that the willingness to pay (WTP) estimator follows a distribution corresponding to the ratio of two Gaussian (normal) variables.

As the precise distribution of the WTP estimator is not known, various methods have been suggested in the literature to construct a confidence interval for the parameter value. One such approach is the Delta method, which assumes that WTP is normally distributed. The variance of WTP is determined by performing a first-order Taylor expansion around the mean value of the variables involved in the ratio and then calculating the variance for this expression. Assuming that the maximum likelihood estimates of the attribute coefficients follow a normal distribution, the Delta method asserts that $\widehat{WTP}$, being a function of these normal variates, will also exhibit asymptotic normality (GATTA et al., 2014).

$$WTP_j \sim N\left(\frac{\beta_j}{\beta_c}, var(\widehat{WTP})\right) \tag{6.15}$$

Here, $var(\widehat{WTP})$ is expressed as,

$$var(\widehat{WTP}) = \left(\widehat{WTP}_{\beta_j}\right)^2 \hat{\sigma}^2{}_{\hat{\beta}_j} + \left(\widehat{WTP}_{\beta_c}\right)^2 \hat{\sigma}^2{}_{\hat{\beta}_c} + 2\,\widehat{WTP}_{\beta_j}\widehat{WTP}_{\beta_c}\hat{\sigma}_{\hat{\beta}_j,\hat{\beta}_c}$$

$$= \left(-1/\hat{\beta}_c\right)^2 \hat{\sigma}^2{}_{\hat{\beta}_j} + \left(\hat{\beta}_j/\hat{\beta}_c{}^2\right)^2 \hat{\sigma}^2{}_{\hat{\beta}_c} + 2\,(-1/\hat{\beta}_c)(\hat{\beta}_j/\hat{\beta}_c{}^2)\hat{\sigma}_{\hat{\beta}_j,\hat{\beta}_c} \tag{6.16}$$

Hence, the confidence interval for WTP at the $(1 - \alpha)$ level, assuming $\widehat{WTP}_{\beta_j}$ and $\widehat{WTP}_{\beta_c}$ are the partial derivatives of $\widehat{WTP}$ with respect to β_j and β_c, respectively, evaluated at the maximum likelihood estimates, and with $\hat{\sigma}^2{}_{\hat{\beta}_j}$, $\hat{\sigma}^2{}_{\hat{\beta}_c}$, and $\hat{\sigma}_{\hat{\beta}_j,\hat{\beta}_c}$ representing, respectively, the estimated variances of $\hat{\beta}_j$ and $\hat{\beta}_c$ and the estimated covariance of $\hat{\beta}_j$ and $\hat{\beta}_c$, can be expressed as $\widehat{WTP} \pm z_{\alpha/2}\, var(\widehat{WTP})$. In this constructed confidence interval, $z_{\alpha/2}$ represents the $(1-\alpha/2)\%$ of the standard normal density. This is calculated using $z_{\alpha/2} = \Phi^{-1}(1 - \alpha/2)$, where ϕ denotes the cumulative standard normal density. The Delta method, employed in this context, is known for its simplicity and its tendency to yield narrow confidence intervals (GATTA et al., 2014).

6.3 Choice sets and experimental designing

In experimental research, discrete choice experiment (DCE) is a method of collecting respondents' preferences (choices) by presenting them samples of choice scenarios drawn from all the possible choice sets. Choice sets are made according to statistical design principles in such a way that it fulfills its necessary statistical conditions and estimation requirements for discrete choice models (BENNETT & ADAMOWICZ, 2001). Correct specifications of the attributes and their levels in constructing a choice set from which individuals make their preferences are critical to the successful conduct of choice experiment and model estimates plausibility (BENNETT & BLAMEY, 2001). The alternatives that are presented to the respondents can be either labeled or unlabeled. For instance, the base scenario may be labeled as status quo and the improved version as hypothetical alternatives.

To maximize choice survey validity, choice alternatives need to be meaningful, relevant and deterministic from respondent's perspective. Furthermore, the size of the choice set (number of alternatives) should be easy to comprehend for the user. On the other hand, sufficient variation among the alternatives must be provided to the respondents to establish statistically the impact of attribute levels on the choices made. Respondents are needed to be presented with the trade-offs that offer them the best possible information about preferences in the sample of interest (the coefficients of the utility function).

The steps followed for designing and proceeding with choice cards are as follows;

1. Selection of attributes: Selection of relevant attributes of the good or service to be valued in the study. This is usually done through literature reviews, focus group discussions, prior testing or direct questioning. Sometimes they may be self-evident because of the nature of the research problem.
2. Assigning the levels: Different levels are assigned to each attribute; levels within each attribute should be exclusive and collectively exhaustive. Meanwhile, they should be realistic and practically achievable by the respondents.
3. Experimental designing: Statistical design theory is used to combine the attribute levels into several alternative scenarios to be presented to the respondents.
4. Construction of choice sets: The profiles made at the experimental designing stage are grouped into choice sets to be presented to the respondents.
5. Collecting preferences: Enumerate the cards with each individual's identity number, conduct the survey and collect the preferences (choices) for model estimations.

Experimental designing is a technique to construct choice sets in such an efficient way that attribute levels are combined into profiles of alternatives and these profiles into choice sets. In designing a choice set, optimal combinations of attributes and their levels to be included in the choice experiment are obtained. Two import properties needed to be attained at the cards designing stage are *orthogonality,* meaning that attributes are uncorrelated, and *balance,* where each level of an attribute appears with the same frequency. Designs which are orthogonal and balanced are called orthogonal arrays as their all-possible combinations are estimable. Additional considerations in designing choice sets are *overlap* and *utility balance,* ensure that no choice set contains alternatives which are too obvious to be selected or rejected by any rational person (respondent).

The best possible design is a full factorial design which includes all the possible combinations of attributes and their levels, however, in general, it is very large and practically not easy to implement in conducting CE. Therefore, fractional factorial design; a subset of all possible combinations is chosen, while following the same criteria of optimality. Different methods (ROSE et al., 2008; STREET & BURGESS, 2007) can be used to reduce all the possible combinations of attribute levels into an optimal subset without compromising on the variations captured by the alternatives.

The main feature of the orthogonal designs is that attributes are treated as statistically independent variables, i.e. have zero correlation, so that it makes possible to estimate the effect of each variable on the outcome variable. The standard approach in health economics, resource economics, marketing, tourism, and transport industry has been to use the orthogonal designs (ALPIZAR et al., 2001).

Even though orthogonal designs have been widely used in applied fields of study, researchers are aware that orthogonality does not cover the realism of the choice tasks and often the designs include dominant alternatives. These designs are also more robust across modeling assumptions but intrinsically result in loss of efficiency (YAO et al., 2015). Therefore, orthogonal designs are appropriate for calibrating liner regression models, not discrete choice models like Multinomial Logit (ROSE & BLIEMER, 2009). It is important to note that utility functions may be linear-in-parameters but the choice probabilities are highly non-linear.

Hence, alternative design generation methods were formulated to construct efficient designs. Efficiency measures goodness of the design and it is inversely related to the variance of the parameter estimates, generally that implies lower standard errors while at the same time controlling for the degree of correlation among parameter estimates. One of the most popular methods to generate efficient designs is based on the minimization of the *D-error,* which is defined in terms of the asymptotic variance-covariance matrix (AVC), which, in turn, depends upon the second derivatives of the log-likelihood function. *D-efficiency,* a relative indicator of design efficiency is based on the following *D-optimality* criterion:

$$D\text{-}efficiency = 100 * (|X'X|\ 1/p)/N) \tag{6.17}$$

Here, p is the number of factors effect in the design (columns in X) and N is the number of requested runs. This measure can be interpreted as the relative number of runs (in percent) that would be required by an optimal orthogonal design to achieve the same value of the determinant $|X'X|$. D-efficiency value ranges from 0 to 100. One of the paramount requirements for constructing D-efficient designs is obtaining the good quality prior parameter values before generating the design. It is always a good practice to generate an initial design based on non-efficient design criteria (random designs or orthogonal designs). This non optimal design then serves as the basis in a pre-test from which a set of prior values can be estimated. Alternatively, it is also common to base prior parameters on existing values in the relevant literature. Recently, many researchers have highlighted the advantages of using efficient designs when dealing with the stated preference (SP) data. Among them the most important is, efficient designs can obtain more reliable estimates with a smaller sample size (BLIEMER & ROSE, 2005).

In this study, to explore exporters' preferences for transport mode choice, a choice experiment technique of stated preference (SP) method was used as research methodology. Based on its stronger statistical propositions and ability to provide more reliable estimates, a D-efficient design was chosen to conduct stated choice experiment. At an early stage, after doing the existing literature review, series of meetings were held with Pakistan mango exporters, mango growers, representatives of Pakistan fruit & vegetable exporters' association (PFVEA), shipping service providers (airlines and shipping lines), custom agents and different state departments' officials to discuss the relevant attributes and their levels considering the specifications of the study area. As such, based on the focus group discussions, expert interviews and meetings with the stakeholders, key attributes were shortlisted. After starting with an initial list of nine attributes, they were reduced to five though pre-test by following the procedure suggested by COAST et al., (2012). Attributes selected for this study and their corresponding levels are illustrated in Table 6.1.

Table 6.1: Attributes and their levels for air and sea mode

Attributes	Air mode				Sea mode			
	Status quo	Level-1	Level-2	Level-3	Status quo	Level-1	Level-2	Level-3
Transport cost *(Rupees/kg)*	170	130	150	190	30	20	40	50
Transit time *(air-hours and sea-days)*	12	8	16	20	28	24	30	32
Loss & damage *(% of shipped quantity)*	5	2	8	11	25	15	20	30
Frequency *(nr. of dep./week)*	70	35	105	140	1	2	3	4
Insurance *(% of loss & damage value)*	0	15	30	50	0	15	30	50

Note: Level-1, Level-2 and Level-3 in each mode are hypothetical scenarios.
Source: Author's compilation

To analyze the relative importance of factors affecting modal choice, the five attributes identified for experimental designing are *transport cost, transit time, loss & damage, frequency* and *insurance.* As transport cost, measured in Rupees/kg, has significant share in total export cost (especially exporting through air), it was selected, given its potential impact on exporters' mode choice decision. It is an important factor in adopting economical transport strategies for enhancing Pakistan's mango export competitiveness in the EU market. Furthermore, transport cost, as a payment vehicle, is also important to include for willingness to pay (WTP) estimates. The second attribute, transit time, represents the average time taken (in hours) by a shipment from its origin point to the destination point. The longer the transit time, the higher are the chances for mango to be damaged because of its perishable nature. The third attribute involves the loss & damage, given the perishable nature of export commodity (fresh mango) and Europe as a distant market for Pakistan mango exporters, it was preferably considered to include this variable in the study. It was observed in the existing literature that, on average, Pakistan mango exporters exporting to the EU by sea nearly suffer a 30% loss of their total shipped quantity. Frequency, number of departures per week, indicates exporters' requirement for flights and shipping line services for exporting mango in peak season.

Lastly, because exporters were very concerned with the loss & damage issue, a hypothetical variable of insurance was added, as a future impact factor to cover their export losses during the shipping stage. It is important to mention that currently exporters are not being offered any insurance protection by shipping companies; hence they are paying no premium for it, but this attribute is included in the study to look for its prospects in the context of exports to far-reaching markets like the EU.

The generation of the final experimental design involved a two-stage procedure. First, a fractional factorial design was constructed and used for the pilot survey to test the accuracy of the experiment as well as to retrieve the information (initial parameter estimates) for the generation of an efficient design. Based on the results from the pilot study, a D-efficient design was therefore generated for the final survey. For details on experimental designing, please see CHOICEMETRICS (2014).

Overall, 5 attributes were identified, each taking 4 levels (three hypothetical levels in addition to the status quo). This representation takes the form of 4^5 matrices, which results in a total of 1024 possible combinations. However, it would have been a difficult task for exporters and almost impossible to evaluate and choose all those combinations. To make the survey length practical and to avoid respondents' fatigue, final choice sets were reduced to 27 by following KUHFELD (2009). Keeping in view respondents' comfort and capturing their rational responses, these 27 choice sets were further arranged into three blocks, each containing 9 choice tasks. For details on blocking technique in stated choice experiments, see LOUVIERE et al., (2000).

Each respondent was presented with one randomly assigned block of nine choice tasks with four alternatives each and asked to choose their most preferred transport mode. Thus, choice data contains nine choices for every exporter. Paper-and-pencil questionnaire tool was used to collect 100 exporters' choice responses by the author in face-to-face interviews. Experimental designing was done by using the software package NGENE 1.1.2 (CHOICEMETRICS, 2014). An example of a choice set is presented in Table 6.2. Both, the choice survey and the main primary data survey for this study were completed at the same time.

Table 6.2: Sample choice card used to collect data

Attributes	Air (Status quo)	Air (Alternative)	Sea (Status quo)	Sea (Alternative)
Transport cost *(Rupees/kg)*	170	130	30	40
Transit time *(air-hours and sea-days)*	12	8	28	30
Loss & damage *(% of shipped quantity)*	5	2	25	20
Frequency *(nr. of departures/week)*	70	35	1	3
Insurance *(% of loss & damage value)*	0	15	0	30
My choice:				

Note: 1 USD = 100 Rupees (2014)
Source: Author's designing

6.4 Empirical models specification

In their study of random coefficients and alternative specific constants (ASCs), KLAIBER & VON HAEFEN (2019) emphasized that however the inclusion of ASC (β_0), in the fixed or random effect models, improves the model fit but at the same time leads to poor performance in prediction of alternatives, which causes over-fitting of the model. Additionally, as balanced and orthogonal experimental design has been used in this study, the intercept's effect gets absorbed into the attribute levels in these designs. In this case, the intercept becomes non-informative and can be excluded from the model. Hence, on the basis of this reasoning, the intercept has not been included in this study's proposed models. Now, the theoretical framework, discussed in 6.2, forms the foundation, upon which the following model has been formulated,

$$U_{ij} = \beta_{TC}TC_{ij} + \beta_{TT}TT_{ij} + \beta_{LD}LD_{ij} + \beta_F F_{ij} + \beta_I I_{ij} + \varepsilon_{ij} \text{ (main effect)} \qquad (6.18)$$

Where sub-indices i and j (j = 1, ..., 4) respectively denote the exporters and the chosen transport mode for export, ensuring maximized utility. The dependent variable, denoted as U, represents the choice among four alternatives: air status quo, air alternative, sea status quo, and sea alternative. The independent variables include transport cost (TC), transit time (TT), loss & damage (LD), frequency (F), and insurance (I). Equation (6.18) has been estimated with the CL model. According to SAGEBIEL et al., (2014), the CL model is subject to certain restrictions. Firstly, the $i.i.d$ (independent and identically distributed) assumption implies that introducing new irrelevant alternatives will not alter the existing substitution pattern, a condition known as the Irrelevance of Independent Alternatives assumption. Secondly, the CL model assumes the homogeneity of respondents, meaning that, aside from the unobserved $i.i.d$ random deviation, all respondents share identical preferences.

To address these limitations and enhance the model's flexibility, various extensions of the CL model exist (LOUVIERE et al., 2000). These extensions relax $i.i.d$ assumption and permit the incorporation of scale and preference heterogeneity into estimation. One notable example is mixed logit model. Therefore, the model defined in equation (6.19) has been estimated as a mixed logit model after the inclusion of two interaction terms, the interaction of insurance (I) with the exporter's education (ED) and the interaction of loss & damage (LD) with exporters' experience (EE).

$$U_{ij} = \beta_{TC}TC_{ij} + \beta_{TT}TT_{ij} + \beta_{LD}LD_{ij} + \beta_F F_{ij} + \beta_I I_{ij} + \beta_I I_{ij} \times \beta_{ED}ED_{ij} + \beta_{LD}LD_{ij} \times \beta_{EE}EE_{ij} + \varepsilon_{ij} \quad \text{(random effect)} \tag{6.19}$$

6.5 Results and discussion

Conditional logit models offer advantages by assuming that the unobserved components (ε_{ij}) in the utility function are independently and identically distributed ($i.i.d$). These models provide straightforward closed-form expressions for choice probabilities. However, a limitation in their ability is to capture preferred variations represented by the unobserved data, and their application becomes restricted due to the $i.i.d$ assumption in logit models. To address these limitations and seek a richer representation of preference variation, and more flexible substitution patterns, the mixed logit model becomes a preferred alternative over the conditional logit model. The mixed logit model overcomes three key limitations of the logit model: it analyzes unobserved (or random) preference variation, allows for unrestricted substitution patterns, and considers correlations in unobserved factors over time.

Unlike conditional logit model, the mixed logit model achieves more flexibility by not relying on a set of fixed coefficients for the entire population (β). Instead, it assumes a distribution of coefficients throughout the population, denoted as $f(\beta \mid \theta)$. This distribution of coefficients effectively addresses the three main limitations of the logit model. Firstly, it models the distribution of unobserved preferences among the decision-makers. Secondly, it imposes a correlation in unobserved utility among alternatives. Finally, it represents individual preferences over time, enhancing the model's capability to capture complex variations in decision-making processes.

The conditional logit model with fixed effects is applied to stated preference data of Pakistan mango exporters comprising of 3,600 observations, testing the significance of attributes influencing choices among the given four options in a choice card. The model exhibited a high level of statistical significance, as indicated by the likelihood ratio test with a chi-square statistic of 574.07 (p-value 0.00), suggesting the joint significance of the attributes. The R^2 of 0.23 reflects a moderate fit, indicating that approximately 23.01% of the variation in the outcome is explained by the model. Turning to the specific attributes, each coefficient estimate provides insights into the influence of the corresponding attribute on the log odds of selecting a specific alternative. In Table 6.3, which shows the results of the basic estimations of CL model, all mode attributes are shown to be highly significant which indicates that these attributes influence the probability of choosing one mode or another. Transport cost, transit time and loss & damage are variables whose significance was a priori expected. Results exhibit the expected signs for all variables, except for frequency.

Transport cost demonstrates a negative association, signifying that as transport cost of the chosen mode increases, exporter may likely switch to an alternative transport mode with relatively low transport cost. This negative relation was also discussed in a study of determinants of transport mode choice by GARCÍA-MENÉNDEZ et al., (2004), where it was reported that an increase in shipping costs would lead to significant reductions in the probability of choosing sea transport over road transport. Furthermore, the negative coefficient of transit time infers that it affects the probability of choosing the given mode adversely. It means exporters are likely to shift from one mode to another if there is an increase in transit time.

Similarly, loss & damage also exhibits a negative effect on mode choice. The significance of this attribute highlights its importance in export of perishable commodity, such as mango. For instance, GARCÍA-MENÉNDEZ et al., (2004) also reported the similar findings that an increase in the loss & damage of goods transported by ship would likely result in fewer decision-makers opting for this transportation option. Moreover, the adverse effect of increase in the frequency of shipments on mode choice is also observed by its negative coefficient. This counterintuitive result of the frequency (F) coefficient is obtained with the unexpected sign, although it is significant at a reasonable confidence level. Similarly, WILMSMEIER & SANCHEZ (2009) in their study of impact of frequency on international transport cost of food reported that enhanced frequency will affect the mode choice negatively if at the same time its shipping cost increases. Lastly, the significant positive coefficient of insurance infers that having a higher percentage of insurance increases utility. PADALIYA & PUNDIR (2022) also highlighted that increase in shipping insurance services can made significant impact on agricultural exports.

Table 6.3: Determinants of exporters' transport mode choice (conditional logit model)

Attributes	Estimate	Std. error	z-value	P>|z|
Transport cost *(Rupees/kg)*	-0.0177	0.0023	-7.68	0.00***
Transit time *(air-hours and sea-days)*	-0.0039	0.0005	-7.71	0.00***
Loss & damage *(% of shipped quantity)*	-0.0876	0.0108	-8.07	0.00***
Frequency *(nr. of departures/week)*	-0.0043	0.0015	-2.82	0.005**
Insurance *(% of loss & damage value)*	0.019	0.002	9.07	0.00***

Note: *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively.
Source: Author's estimations

Furthermore, a random effect model (see Table 6.4), is also discussed with the same attributes. The findings of this model align with the discussion of the previous model (main effect). The estimate of transport cost indicates that, on average, a one-unit increase in transport cost, negatively impacts the probability of exporter's choice of any given mode. Similar signs of coefficients for attributes like transit time, and loss & damage were also found. The negative coefficients of these attributes imply that an elevation in their values may increase the probability of selection of other alternatives. However, the positive estimate of insurance suggests that higher percentages of insurance are associated with an increase in the likelihood of the exporter's continuing with their current modes.

In the random effects model, the existence of systematic variations in the preferences of exporters was also analyzed by specifying the socio-economic variables that are indicative of the characteristics of exporters interacting with modal variables. These socio-economic variables are incorporated as interaction terms, first one to describe the influence of education on the relation between insurance adaptability and exporter's mode choice, and second one to check the influence of experience on the relation between loss & damage and exporter's transport mode choice. For air alternative, the education interaction with insurance is significant whereas the interaction of experience and loss & damage accounts for non-significant effect, showing no effect on switching from air status quo to air alternative. The positive coefficient of education interaction infers that educated exporters with insurance opportunity are more likely to continue mango exports via air status quo instead of choosing air alternative. The alternative, sea status quo, also yielded similar results to air alternative. The interaction of education is found to be significantly affecting the mode choice of sea status quo while the impact of experience interaction is observed non-significant. The positive coefficient of education interaction suggests that higher education levels with export insurance positively influence the likelihood of continuing with base alternative, air status quo, compared to sea status quo.

Lastly, for sea alternative, along with education interaction, experience interaction is also found significantly influencing the exporter's choice of shifting from air status quo to sea alternative. The positive coefficient of experience interaction indicates that, on average, with each additional year of experience at given loss & damage, the likelihood of choosing air status quo compared to sea alternative increases. Similarly, the positive influence of education remains consistent in sea alternative case, suggesting the education plays important role in impacting exporters' decision to opt for air status quo in mango export to the EU.

Table 6.4: Determinants of exporters' transport mode choice (mixed logit model)

Attributes	Estimate	Std. error	z-value	P>|z|
Transport cost *(Rupees/kg)*	-0.019	0.003	-7.81	0.00***
Transit time *(air-hours and sea-days)*	-0.011	0.002	-7.35	0.00***
Loss & damage *(% of shipped quantity)*	-0.072	0.012	-6.01	0.00***
Frequency *(nr. of departures/week)*	-0.0006	0.002	-0.36	0.71
Insurance *(% of loss & damage value)*	0.028	0.004	7.21	0.00***
Air $_{\text{Status quo}}$ (base alternative)				
Air $_{\text{Alternative}}$				
Loss & damage × Experience	-0.007	0.11	-0.61	0.54
Insurance × Education	0.04	0.02	2.00	0.05*
Constant	-1.15	0.27	-4.25	0.00***
Sea $_{\text{Status quo}}$				
Loss & damage × Experience	0.01	0.03	0.45	0.65
Insurance × Education	0.35	0.07	4.66	0.00***
Constant	1.32	1.65	0.80	0.42
Sea $_{\text{Alternative}}$				
Loss & damage × Experience	0.077	0.013	5.85	0.00***
Insurance × Education	0.43	0.04	9.82	0.00***
Constant	0.15	1.32	0.12	0.90

Note: *****, ******, and ******* indicate significance at 10%, 5%, and 1% levels, respectively.

Source: Author's estimations

After discussing the influence of attributes on mode choice in CL and ML model, Table 6.5 presents the WTP values derived from these models in the DCE, reflecting the preferences of mango exporters in Pakistan under specific conditions. The WTP values signify the monetary worth assigned by exporters to alterations in different attributes influencing their choices between different transportation modes. The 95% confidence intervals for WTP values have been provided by using the delta method.

In terms of transit time, a reduction of 10% prompts a higher WTP according to the ML model compared to the CL model. The broad confidence interval for the ML model suggests greater uncertainty in these preferences. Regarding the attribute of loss & damage, a 25% reduction results in a WTP of 4.94 Rs/kg for the CL model and 3.66 Rs/kg for the ML model. This indicates that exporters are willing to pay extra for a decrease in loss and damage, with the ML model estimating a more reliable WTP value due to precise confidence interval than CL model.

The impact of increased frequency, one additional departure per day, reveals contrasting preferences. The CL model indicates a WTP of 0.25 Rs/kg, while the ML model suggests a much lower WTP of 0.03 Rs/kg. This implies that the ML model captures a more conservative preference for increased frequency. For insurance, recovering 50% of loss & damage value, both models estimated a willingness to pay between 1.08 and 1.41 Rs/kg. Notably, the negative sign is a result of the variable specification, where the respondents prefer to have higher remuneration values, see WTP formula specification in (6.14), e.g. in contrast to transit time, where lower values are preferred.

Table 6.5: Willingness to pay of exporters for transport mode choice attributes

Attributes	Conditions	Conditional logit model			Mixed logit model		
		WTP	Lower	Upper	WTP	Lower	Upper
Transit time	If 10% is reduced	0.23	0.19	0.26	0.58	0.37	0.78
Loss & damage	If 25% is reduced	4.94	3.42	6.46	3.66	2.21	5.12
Frequency	If 1 departure/day is increased	0.25	0.07	0.43	0.03	-0.19	0.13
Insurance	If 50% of loss & damage value is recovered	-1.08	0.69	1.40	-1.41	-1.90	0.91

Note: WTP is measured in Rs/kg. Lower and upper values indicate confidence interval bounds.
Source: Author’s estimations

6.6 Summary and conclusion

In the exploration of discrete choice models for mango exporters in Pakistan, the Conditional logit (CL) model provided valuable highlights into the influence of various determinants on the log odds of transport mode choice. Notably, attributes such as transport cost, transit time, loss & damage, and frequency demonstrated significant negative effects, implementing that increase in these factors negatively influence the choice of transport modes. Conversely, insurance showed a significant positive association, suggesting that a higher percentage of insurance positively impacts mode choice, increasing utility for exporters.

In the Mixed logit (ML) model, the random effects analysis revealed nuanced findings. Similar to the CL model, negative coefficients for attributes like transport cost, transit time, and loss & damage indicated that increase in these attributes may have a negative impact on the likelihood of selecting any alternative. Interestingly, the positive estimate for insurance underscored that a higher percentage of insurance positively influenced exporters' choices. Moreover, the interaction variables of education and experience coefficients highlighted their intricate roles in influencing choices across different alternatives, emphasizing the significance of individuals' socioeconomic characteristics.

The estimation of CL and ML models led to the computation of Willingness-to-Pay (WTP) values, providing a monetary measure of mango exporters' preferences for alterations in various attributes. Noteworthy findings include the higher WTP for a 10% reduction in transit time in the ML model compared to the CL model, indicating greater value placed on time savings. Similarly, the CL model estimated a higher WTP for a 25% reduction in loss & damage, revealing a stronger preference for risk mitigation. The divergence in WTP values for increased frequency suggests a nuanced preference captured by the ML model, indicating a conservative stance among exporters.

7 IMPORT DEMAND AND EXPORT COMPETITIVENESS

This chapter aims to investigate the import demand of mango in the EU market and the export competitiveness among its leading supplying countries, with the usage of secondary data. Almost ideal demand system (AIDS) modeling is purposively implemented to do import demand analysis separately for two distinctive trade scenarios; extra-EU[25] and intra-EU[26] trade. Different trade indices are calculated to examine the extra-EU (non-EU) mango exporting countries' evolving comparative advantage in their mango exports to the EU market. It aims to understand how variations in mango export prices, hence the quantity supplied by the exporting countries influence mango demand in the EU. The estimation of demand elasticities is carried out to assess the impact of expenditure and price fluctuations on mango import demand. Pakistan's mango export performance in comparison to other leading exporters to the EU market is explored to look for valuable insights into its evolving dynamics of mango trade and future implications for export growth in this high value market.

7.1 Introduction

The global trade landscape is constantly evolving, driven by factors such as technological advancements and changing in consumer preferences, which results in shifts in comparative advantages. In this context, the export dynamics of agricultural products, including tropical fruits like mangoes, are of paramount importance. European market, as one of the world's largest importers of fresh mangoes, stands at the epicenter of this trade landscape.

This chapter comprises of two distinct sections; import demand and export competitiveness, the earlier one is underpinned by the AIDS framework while the later one is evaluated through export indices. The first section scrutinizes mango import dynamics in the context of both extra-EU and intra-EU trade. The cornerstone of the import demand analysis lies in the application of the almost ideal demand system (AIDS), a robust and versatile tool meticulously designed to analyze the complex interplay of factors that underlie mango imports to the EU. It is examined

[25] The partner country is the non-EU country of origin of the goods, as defined under union customs legislation (EUROSTAT, 2023).

[26] The partner country is the EU member state, from which the goods are dispatched to another member state for the arrival of the goods according to the trade contract (EUROSTAT, 2023).

how changes in mango export prices and the economic capacity of importing countries, i.e., expenditure; interweave the demand for mangoes across various importing countries of the EU. The analysis delves into the expenditure and price elasticities, both in terms of a country's own-price and cross-price elasticities, to investigate the income and price changes effect on mango import demand by the EU countries.

In the second section, the focus shifts to the evolving comparative advantage among non-EU exporting countries including Pakistan, a notable mango exporter to the EU market. Methodological framework encompasses critical export indices, such as, Balassa's export index of revealed comparative advantage (RCA), the logarithmic variant of this index (lnRCA), the revealed symmetric comparative advantage (RSCA), and the comparative export performance (CEP) index. By meticulously comparing Pakistan's performance with other prominent mango-exporting countries, such as, Brazil, Peru, Israel and Cote d’Ivoire, it is aimed to observe vital insights into its mango trade dynamics and their implications on export growth in the EU.

7.2 Analytical framework

7.2.1 Almost Ideal Demand System (AIDS)

The Almost ideal demand system (AIDS) originally introduced by DEATON & MUELLBAUER (1980) is a consumer demand model used primarily to study consumer behavior; both at aggregate (macroeconomic) and disaggregate levels (household data). It gives a second-order approximation[27] to a demand system. It is estimated as a set of multiple mathematical equations; it satisfies the axioms of order, consistent with the budget constraints of consumer theory, and is simple to estimate because of its flexible functional form. Many researchers have used the AIDS model in applied demand analyses to find the optimal allocation of budget (expenditure) either for a broad category of consumer goods or a single commodity. It readily provides regression coefficients, expenditure elasticity, own price, and cross-price elasticities of import demand, hence it was selected for empirical estimation in this research.

Applied to imports, the AIDS model assumes that purchasing decisions are made in a two-stage budgeting procedure. In the first stage, total expenditure by the importers is allocated over a broad group of commodity suppliers. In the second stage, from the expenditure determined at the first stage, the budget is allocated over individual

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[27] It represents a quadratic polynomial or parabola function that fits the multiple data points.

supply sources, including domestic ones. Domestic and foreign supply sources are assumed to be distinct and separable groups. The AIDS model is developed from a simple cost function that permits exact aggregation over consumers' preferences. In the process of estimating the demand system model, a time series structure for the data has been incorporated to account for temporal variations. Basic AIDS model is given as follows:

$$w_{it} = \alpha_i + \sum_j \gamma_{ij} \ln p_{jt} + \beta_i \ln(M_t/P_t) + \varepsilon_{it} \quad (7.1)$$

In this equation, α_i, γ_{ij} and β_i are the parameters whereas w_{it} denotes the budget share of the good for the i^{th} country at time t being analyzed, p_{jt} signifies the price of the good in the j^{th} country at time t, M_t represents the aggregate expenditure on the good from all the countries under study, and lastly P_t represents the price index.

The AIDS model outlined in equation (7.1) exhibits non-linearity due to the presence of the translog price index ($\ln P_t$) (CHANG & NGUYEN, 2002). According to GREEN & ALSTON (1990), the version of the model that incorporates Stone price index ($\ln P^s$) i.e., $\ln P_t^S = \sum_i w_{it} \ln(p_{it})$ introduced by BLANCIFORTI & GREEN (1983), is commonly referred as the linear approximate AIDS (LA/AIDS). Linear AIDS model has been broadly used in applied demand analyses of agricultural products (CHANG & NGUYEN, 2002; TALJAARD et al., 2004).

Several studies have highlighted the advantages of LA/AIDS compared to other demand system models (ALSTON & CHALFANT, 1993; EALES & UNNEVEHR, 1994; GLEWWE, 2001). Firstly, it is consistent with the consumer demand theory because it is derived explicitly from a cost minimization function. Its flexible functional form provides a ready approximation to any demand system, consequently limiting specification biases. Furthermore, its compatibility with aggregation over consumers can model consumer behavior with both aggregated (macroeconomic) and disaggregated (household survey) data (DEATON & MUELLBAUER, 1980). Lastly, it overcomes the limitations of a single equation approach and measures concisely how consumers make decisions to maximize their utility under given budget constraints.

ALSTON, FOSTER & GREEN (1994) noted that the AIDS model produced less reliable estimates in cases of high multicollinearity among prices. In contrast, the LA/AIDS provides more reliable estimates in terms of goodness of fit of the model. Additionally, the LA/AIDS incorporates an elasticity expression that assumes constant and endogenous budget shares on the right side of the demand equations (PARAGUAS & KAMIL, 2005; ALSTON et al., 1994).

However, the utilization of Stone's price index has faced scrutiny in literature, including CHALFANT (1987), GREEN & ALSTON (1990), PASHARDES (1993), BUSE (1998), and MOSCHINI (1995), and there are various reasons for this critique. Firstly, the inclusion of budget shares w_{it} in the Stone index results in their appearance on both; the left- and right-hand sides of the estimated share equation of the model. This introduces a correlation between the regressor $\ln(M_t/P_t)$ and the disturbance term ε_{it}, leading to a simultaneity bias in the estimation process, as noted by EALES & UNNEVEHR (1988, p. 522). Secondly, the Stone price index lacks invariance to changes in units of measurement, meaning that results are dependent on the measurement units of prices. Recognizing this limitation, MOSCHINI (1995) suggests replacing the Stone price index in the LA/AIDS with the log-linear analog of the Laspeyres price index ($\ln P_t^L$) to mitigate such issues. Hence, the Laspeyres price index utilized in estimation of the LA/AIDS model for this study is presented in equation (7.2).

$$\ln P_t^L = \sum\nolimits_k w_{k0} \ln(p_{kt}/p_{k0}) \tag{7.2}$$

Where, w_{k0} and p_{kt} indicate expenditure shares and prices in *base* period (e.g. at sample mean values) respectively. However, microeconomics household theory, under the assumption of utility maximization, places certain constraints on the coefficients derived from the LA/AIDS (HENNINGSEN, 2017). These conditions serve to ensure the consistency of the estimates with the economic theory.

The *adding-up* condition ensures that the expenditure shares always sum up to one ($\sum_i w_i = 1$). The condition is satisfied if,

$$\sum\nolimits_{i=1}^{n} \alpha_i = 1, \sum\nolimits_{i=1}^{n} \gamma_{ij} = 1, \sum\nolimits_{i=1}^{n} \beta_i = 1 \tag{7.3}$$

The *homogeneity* condition ensures the absence of ‘money illusion’, meaning that if all prices and income, change by the same rate, the quantities consumed do not change. This condition is fulfilled if,

$$\sum\nolimits_j \gamma_{ij} = 0 \tag{7.4}$$

Lastly, the *symmetry* condition is fulfilled if,

$$\gamma_{ij} = \gamma_{ji} \tag{7.5}$$

Income elasticities; uncompensated (Marshallian), and compensated (Hicksian) elasticities have been computed by utilizing the formulae outlined in equations (7.6-7.8). The income elasticity (η_i) for exporting country i is represented as,

$$\eta_i = 1 + \frac{\beta_i}{w_i} \tag{7.6}$$

The uncompensated (Marshallian) price elasticities (e_{ij}^{u}) for exporting country i to country j, are computed by using the following expression,

$$e_{ij}^{u} = \frac{\gamma_{ij} - \beta_i w_j}{w_i} \tag{7.7}$$

Whereas, the compensated (Hicksian) price elasticities (e_{ij}^{c}) for exporting country i to country j, have been calculated by using the formula derived from the Slutsky equation,

$$e_{ij}^{c} = e_{ij}^{u} - \eta_i w_j \tag{7.8}$$

Generally, in mathematical estimations, there are two types of equations; single equations and system equations. For estimations of these equations; two fundamental approaches are commonly suggested in literature; least-squares and maximum-likelihood method. For single equation least squares' estimations, standard OLS procedure is used while in the case of system equations; two-stage-least squares (2SLS) and three-stage-least squares (3SLS) methods are considered suitable. For maximum-likelihood estimates; limited information maximum likelihood (LIML) and full information maximum likelihood (FIML) methods are used, respectively. 3SLS and FIML are system methods that use information concerning the endogenous variables in the system and take into account covariance across error terms, hence their estimates are considered to be asymptotically efficient if there is no model specification error.

Seemingly unrelated regression (SUR) and three-stage-least squares (3SLS) are popular methods for joint estimations of multiple equations. SUR, also called joint generalized least squares (JGLS) or Zellner estimations is a generalization of OLS for multi-equation systems. SUR is a two-stage method (2SLS); in the first step, it estimates OLS regression to compute residuals and in the second step those OLS residuals are used to estimate the covariance matrix across the equations. Like OLS, the SUR method assumes that all the regressors are independent variables but SUR uses the correlations among error terms in different equations to improve the regression estimates. Theoretically, in large samples, SUR parameters will always be at least as efficient as OLS estimates, provided that models' equations are correctly specified. If the sample size is small and across-equations correlations are also weak then OLS should be preferred to SUR because the consequences of model specification error with SUR are more serious than the OLS. Further, SUR (2SLS) estimates will be as efficient as of OLS if at least one explanatory variable isn't changed in an equation.

The 3SLS method generalizes the 2SLS (SUR) to take account of the correlations among equations in the same way as SUR generalizes the OLS. 3SLS requires three steps; first-stage regressions to get predicted values for the endogenous regressors, a two-stage least squares step to get residuals to estimate the cross-equations correlation matrix, and a final 3SLS estimation step which corrects correlation among errors across equations. Factually, 3SLS is a combination of Instrumental variables (IV) and Generalized Least Squares (GLS). The use of IV allows us to have more consistent and efficient estimates than SUR and normal OLS.

For advanced estimations, both the SUR and 3SLS methods can be iterated by re-computing the estimates of cross-equations covariance matrix from the SUR and 3SLS residuals and then computing the new SUR or 3SLS estimates based on this updated new covariance matrix estimation, continuing this iteration step until convergences produce iterated-SUR or iterated-3SLS. These iterated estimates will be expected highly efficient, consistent, and asymptotic. Hence, on the basis of the above-mentioned arguments, the 3SLS method was chosen to estimate the final AIDS model results for this study.

7.2.2 Export indices for comparative advantage

In this section, for the estimation of comparative advantage, four export indices of trade specialization have been employed. Following is the brief description for each of the export indices used.

a) Revealed comparative advantage (RCA):

Export index, revealed comparative advantage (RCA) is defined as a country's export ratio of a specific commodity category to its overall merchandise export share (BALASSA & NOLAND, 1989). When a country's share of global exports in a particular commodity surpasses its share of global exports in all commodities, the RCA value exceeds 1. Thus, a country is deemed to possess revealed comparative advantage in that product for which its market share on the global stage surpasses its average share of worldwide exports. The RCA for a given country m in a particular commodity n denoted as $RCA_{m,n}$, is expressed as follows,

$$RCA_{m,n} = \frac{(X_{mn} / X_{wn})}{(X_{mt} / X_{wt})} \tag{7.9}$$

Here, X_{mn} represents the exports of commodity n by country m, X_{wn} stands for the world exports of commodity n, while X_{mt} signifies the total exports of country m, and X_{wt} denotes the total world exports. For the assessment of comparative advantage, as proposed by (HINLOOPEN & MARREWIJK, 2001), the following classification based on Balassa's RCA is adopted:

No comparative advantage- when the RCA value is greater than or equal to 0 but less than or equal to 1.

Weak comparative advantage- when the RCA value is greater than 1 but less than or equal to 2.

Moderate comparative advantage- when the RCA value is greater than 2 but less than or equal to 4.

Strong comparative advantage- when the RCA value is 4 or above.

This classification scheme of RCA values helps in unveiling the magnitude of a country's comparative advantage in a particular product category and is a valuable tool for assessing export competitiveness.

b) Revealed symmetric comparative advantage (RSCA)

As mentioned earlier, when the RCA exceeds a value of 1, it indicates that a country specializes in a particular commodity (or sector), whereas if the RCA is less than 1, it signifies that the country is not specialized or, in other words, "under-specialized" in that commodity. However, the RCA inherently lacks symmetry, as it cannot be easily compared when it strays from its neutral value of 1. To address this issue, LAURSEN (2015) introduced a new index called the revealed symmetric comparative advantage (RSCA), which provides a more balanced and symmetric measure of comparative advantage. RSCA is calculated using the formula presented in equation (7.10),

$$RSCA_{m,n} = \frac{RCA_{m,n} - 1}{RCA_{m,n} + 1} \quad (7.10)$$

The resulting $RSCA_{m,n}$ value ranges between $+1.0$ and -1.0. LAURSEN (2015) put forth the argument that the RCA index should consistently be made symmetric, especially for applications involving econometric analysis. The rationale behind this argument is that the 'pure' RCA, in its unadjusted form, lacks comparability on both sides of unity. In this unadjusted state, the index spans from 0 to 1 when categorizing a country as not-specialized in a particular sector, and it extends from 1 to infinity when indicating specialization. According to NWACHUKUE et al., (2010), an important economic advantage of this method is that it assigns equal weight to changes below unity (in this case, zero) as it does to changes above unity, ensuring fairness in assessing comparative advantage. From the perspective of normality, RSCA emerges as the optimal alternative.

c) Inversion revealed comparative advantage (lnRCA)

VOLLRATH (1991) proposes that taking the logarithm of the RCA can also address the issue of asymmetry in the RCA index. Although this method provides valuable findings, it is important to note that the adjusted index remains undefined when applied to a country that has no exports in a specific sector. Although, lnRCA shares similar characteristics with the RSCA, yet it possesses the distinct advantage of being definable even in cases where a sector exhibits zero exports. In other words, alongside RSCA, the natural logarithmic version of RCA (lnRCA) can also be computed to address the issue of skewness (DALUM, 1996).

According to FAUSTINO (2008) and VOLLRATH (1991), this transformation not only mitigates the limitations of the RCA index but also provides a more robust estimate of the competitiveness of export commodities. As a rule of thumb, when lnRCA (log-RCA) value is greater than 0, it signifies the presence of comparative advantage in the export of a particular commodity. Conversely, if the lnRCA value is less than 0, it indicates a comparative disadvantage in the same context.

d) Comparative export performance index (CEP)

To facilitate a direct comparison of export competitiveness between any two countries, the comparative export performance index (CEP) is very instrumental, as suggested by BOBIRCA (2011) and DONGES (1982). This index hinges on export shares, enabling the comparison of findings between two countries. The formula utilized to compute the CEP index, as provided by BOBIRCA (2011), is as follows:

$$CEP = \frac{X_{m_1 n}/X_{m_1 t}}{X_{m_2 n}/X_{m_2 t}} \quad (7.11)$$

Here, $X_{m_1 n}$ represents the exports of country m_1 in a specific commodity category n, $X_{m_1 t}$ signifies the total exports of country m_1, $X_{m_2 n}$ stands for the exports of country m_2 in the same commodity category, and $X_{m_2 t}$ denotes the total exports of country m_2. The CEP index serves as a measure of competitive export advantage held by country m_1 over country m_2. If the index value surpasses 1, it indicates that country m_1 possesses a competitive advantage in exports relative to country m_2.

7.3 Description of the variables

For the AIDS analysis of extra-EU and intra-EU import demand, annual mango import data of 13 years, from 2008 to 2020 has been used. Data is extracted from the EUROSTAT[28] database using HS code 080450. The dataset includes essential variables such as mango import quantity (kg) and import value (€). From this data, prices and budget shares have been calculated, pivotal in comprehending the dynamics of mango imports. For the first segment of AIDS analysis of extra-EU imports, the top five mango exporting countries to EU, namely Brazil, Peru, Israel, Cote d'Ivoire, and Pakistan, in addition to a category of rest of the world (ROW) has been selected on the basis of their export values.

In the second segment of AIDS analysis, intra-EU imports, the import demand for mangoes by various EU countries from fellow top EU member states acting as "re-exporters" is examined. Countries, namely Netherlands, Spain, Germany, France, and Belgium, alongside the category of rest of the EU (ROEU), have been identified, based on their export values. By exploring the dynamics of mango imports within the EU, this analysis provides valuable insights into the trade patterns and preferences of EU countries for mangoes, considering both quantity and value aspects. Moreover, for empirical estimations of AIDS, the "micEconAids" package, (HENNINGSEN, 2014) of statistical software R has been used.

Lastly, in export competitiveness analysis, trade data retrieved from FAOSTAT and WITS databases from 2008 to 2020, has been utilized to compute export specialization and competitive measures, based on factor intensity. In this section,

[28] European Union's statistical office (EUROSTAT) https://trade.ec.europa.eu

export indices for Pakistan and its major competitors in EU mango trade, including Brazil, Peru, Israel and Cote d'Ivoire are calculated.

7.4 Results and discussion

7.4.1 AIDS model estimations for extra-EU imports

Before discussing the estimations of LA/AIDS for extra-EU imports, this section presents the summary statistics of mango trading variables of extra-EU countries (see Table 7.1). The narrow range of mango prices for countries like Brazil suggests a degree of price stability in their exports to the EU. Conversely, the wider range of prices for countries like Pakistan indicates more volatile price fluctuations, which could be influenced by factors such as supply chain disruptions, quality control standards, or changes in demand. Higher mean prices might indicate superior quality or specialized mango varieties; contributing to the diversity in the mango import market. Countries with large differences between their minimum and maximum budget shares (e.g., Brazil and Peru) reveal fluctuations in their export volumes.

Table 7.1: Summary statistics of variables involved in LA/AIDS model for extra-EU exporters

Variables	Min	Max	Mean	Variance
Brazil export price (€/kg)	1.04	1.65	1.31	0.03
Peru export price (€/kg)	0.91	1.70	1.31	0.08
Israel export price (€/kg)	1.17	2.18	1.65	0.09
Cote d'Ivoire export price (€/kg)	0.85	1.16	1.00	0.01
Pakistan export price (€/kg)	1.32	3.84	2.03	0.46
Rest of the world export price (€/kg)	1.31	2.31	1.82	0.12
Brazil budget share (%)	29.88	42.30	34.97	10.68
Peru budget share (%)	17.15	33.66	24.14	20.50
Israel budget share (%)	3.68	8.52	5.49	1.57
Cote d'Ivoire budget share (%)	3.52	5.74	4.66	0.39
Pakistan budget share (%)	1.07	7.21	4.29	4.14
Rest of world budget share (%)	21.51	29.15	26.45	5.11
Expenditure (€ million)	237.2	690.7	433.6	23797.82

Source: Author's calculations based on EUROSTAT database (2008-2020)

Moreover, the high variance in budget share of Peru suggests that it comprise of diverse market dynamics. The substantial spread in expenditure values highlights the varying income impact of mango-importing countries on demand over the years.

A visual representation of the total annual mango exports (ton) for each of the extra-EU countries has been illustrated in Figure 7.1. By looking at this chart, several observations can be made. Brazil consistently holds the highest position in terms of mango exports throughout the years. Brazil's exports are consistently the highest, indicating a sustained dominance in the EU mango import market. Peru has demonstrated substantial growth in its mango exports over the years. A consistent increase in Peru's exports highlights its competitiveness and expanding market presence. Not surpassing Brazil or Peru, Israel also maintains a stable and consistent market share in EU mango imports. Cote d'Ivoire's exports exhibit noticeable fluctuations over the years. Pakistan's exports show a variable trajectory, starting lower and then fluctuating in subsequent years but not gaining a significant increase in export quantity as compared to other extra-EU countries.

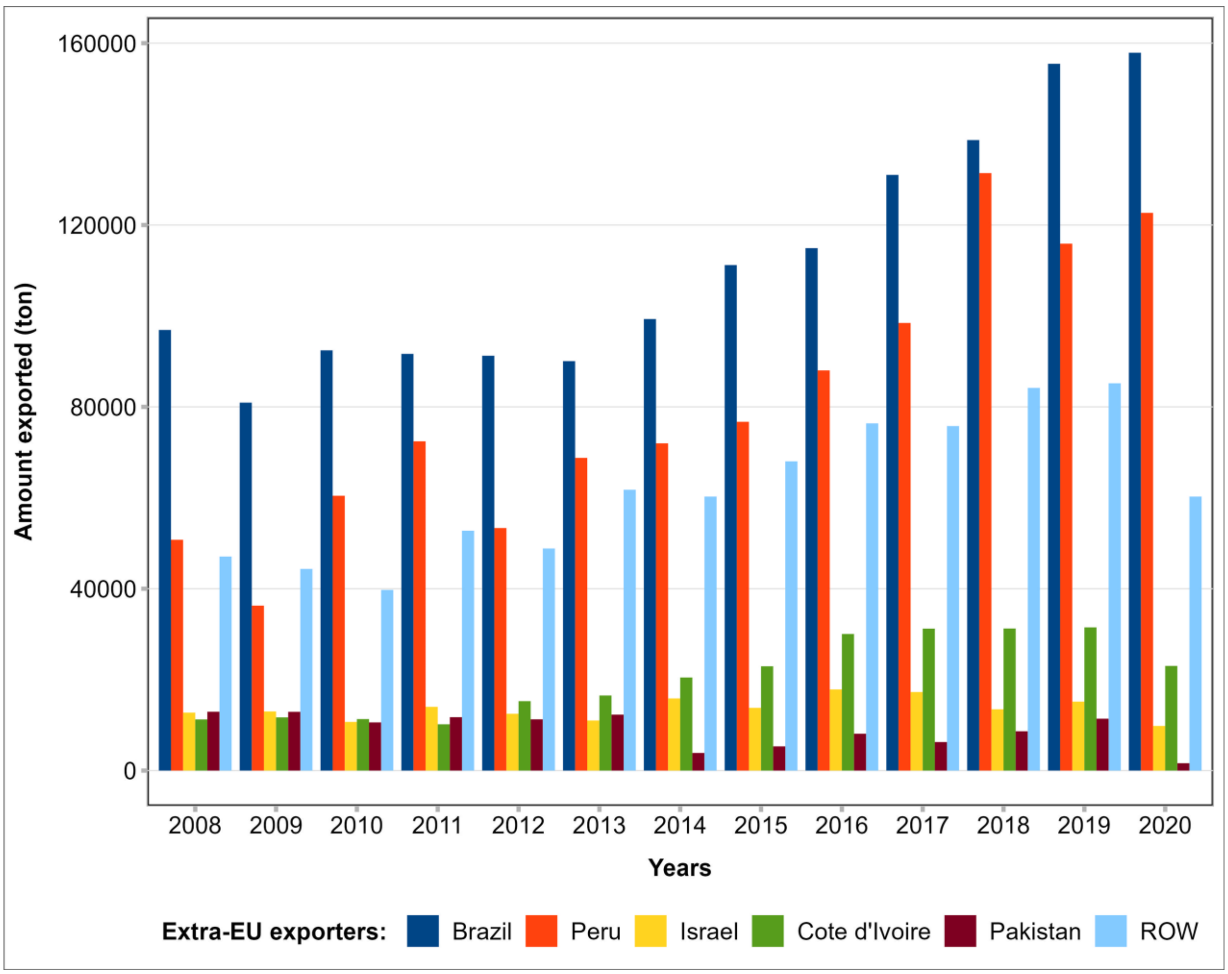

Figure 7.1: Total annual mango exports of extra-EU countries (2008-2020)

Source: Author's illustration based on EUROSTAT data (2020)

Next to the exploration of total mango export, a time series plot of the market share (%) by quantity in the total mango exports for each extra-EU exporting country has been discussed (see Figure 7.2). It can be observed that Brazil's market share has experienced fluctuations over time but consistently maintains its dominance over other countries; starting as a dominant exporter in 2008, gradually decreasing its position until 2013, and later on following resurgence until 2020. This suggests that while Brazil might have faced some challenges, it managed to regain and even strengthen its position in the EU mango market. Peru's market share displayed a noticeable upward trend from 2008 to 2018, indicating consistent growth and then experienced a slight decline in the later years but regained its previous position. Israel's market share exhibits relative stability throughout the years, with small declines towards the end of the years. Israel's consistent presence suggests a steady market strategy with limited variations in its market share.

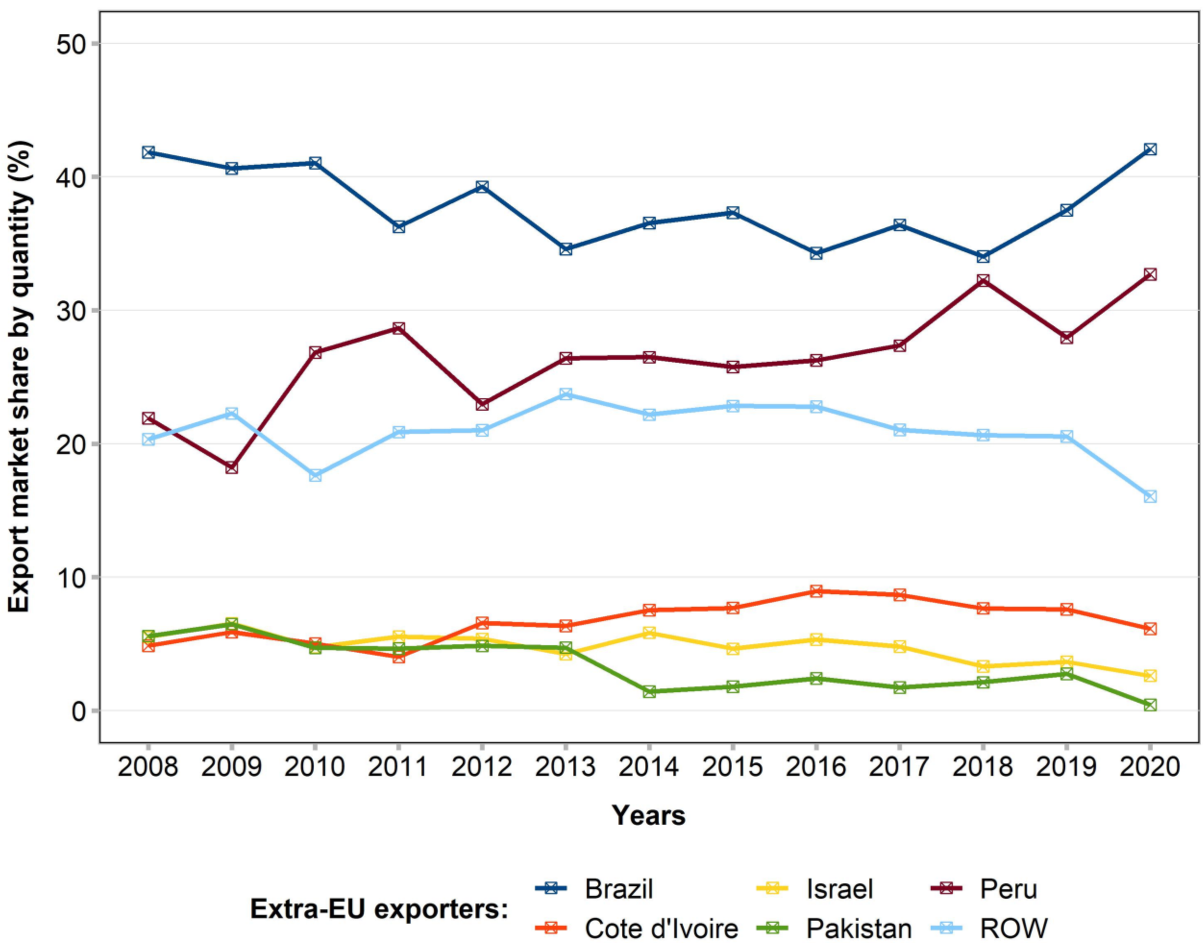

Figure 7.2: Export market share of extra-EU countries by quantity (2008-2020)

Source: Author's illustration based on EUROSTAT data (2020)

Cote d'Ivoire's market shares initially dipped but showed a quick recovery and persistent continuity in its exports over the following years. Pakistan's market share has been relatively volatile with notable fluctuations. While experiencing periods of marginal growth, there are also significant drops in its market share, suggesting responsiveness to market dynamics and potential shifts in import patterns.

The market share (%) by value for each of the extra-EU countries is illustrated in Figure 7.3. Similar to the market share by quantity, Brazil's market share by value also displays fluctuations but remains dominant in the market despite showing a gradual decline compared to its starting years. Peru's market share by value shows somewhat steady growth over time until it depicts a sharp increase in 2020, which means Peru is strengthening its position in the EU market. This also aligns with the previous observation of Peru's growth by quantity share.

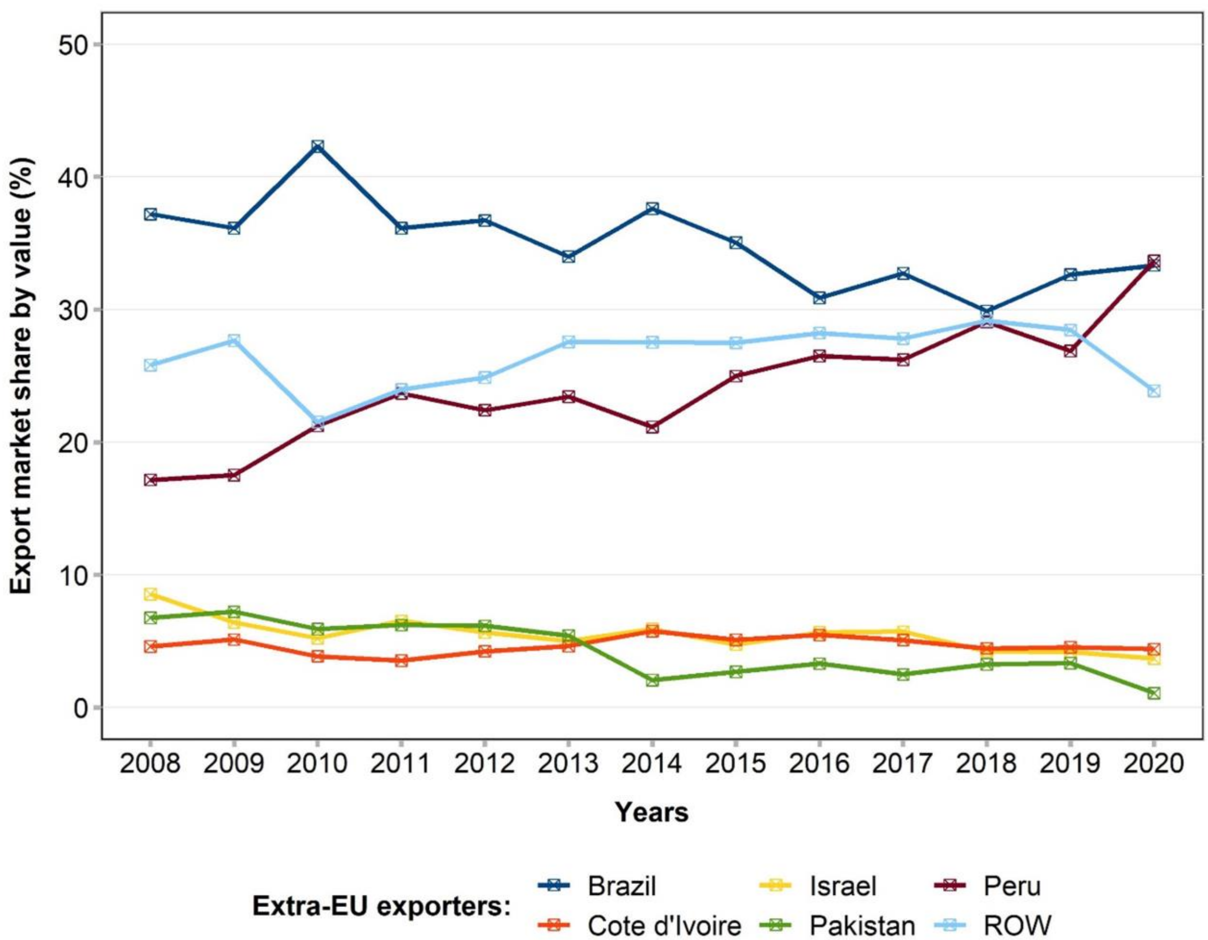

Figure 7.3: Export market share of extra-EU countries by value (2008-2020)

Source: Author's illustration based on EUROSTAT data (2020)

Israel's market share by value follows a pattern of stability similar to its previous finding of quantity share. Cote d'Ivoire's market share by value mirrors its quantity-based findings, displaying a general persistent trend over the years. Pakistan's market share by value exhibits volatility, akin to quantity-based findings. This suggests that Pakistan's market position is responsive to changes in pricing dynamics or other market conditions. This also indicates that the EU import response to Pakistan mango is relatively lower compared to other countries. The consistent fluctuations in both measures of the ROW imply that market positioning has experienced dynamic shifts over the years.

After briefing the market share conditions of extra-EU countries, their estimated results of the LA/AIDS model are discussed. The method of estimation employed is 3SLS, a statistical technique to estimate a system of equations simultaneously. The LA/AIDS estimated model results, restricted by three conditions of adding-up, homogeneity, and symmetry on coefficients are presented in Table 7.2.

Table 7.2: Estimated coefficients of LA/AIDS model for extra-EU exporters

Budget Share / Price	Brazil	Peru	Israel	Cote d'Ivoire	Pakistan	ROW
Brazil	0.02 (0.06)	-0.08** (0.35)	0.02 (0.03)	0.0003 (0.02)	-0.005 (0.03)	-0.05 (0.08)
Peru	-0.08** (0.04)	0.02 (0.04)	0.06** (0.03)	-0.001 (0.02)	0.07*** (0.02)	-0.07 (0.06)
Israel	0.02 (0.03)	0.06** (0.03)	0.006 (0.04)	-0.004 (0.02)	0.003 (0.02)	-0.09 (0.06)
Cote d'Ivoire	0.0003 (0.02)	-0.001 (0.02)	-0.004 (0.02)	-0.01 (0.02)	0.006 (0.02)	0.008 (0.04)
Pakistan	-0.005 (0.03)	0.07*** (0.02)	0.002 (0.02)	0.01 (0.02)	-0.05** (0.03)	-0.01 (0.05)
ROW	0.05 (0.08)	-0.07 (0.06)	-0.09 (0.06)	0.01 (0.03)	-0.01 (0.05)	0.12 (0.14)
Total expenditure	-0.01** (0.04)	0.09*** (0.02)	-0.01 (0.02)	-0.002 (0.01)	-0.04* (0.02)	0.07 (0.05)
Constant	2.45*** (0.77)	-0.168*** (0.47)	0.33 (0.45)	0.09 (0.35)	0.96* (0.50)	-1.16 (1.001)
R-square	0.74	0.95	0.17	0.06	0.74	0.27

Note: *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively. Numbers in the brackets are standard errors.
Source: Author's estimations

The estimated coefficients associated with total expenditure (income) are found statistically significant for Brazil, Peru, and Pakistan whereas it is found insignificant for other countries. Expenditure coefficients for Brazil and Pakistan suggest that a one-unit increase in total expenditure of importing countries will result in a -0.01 and -0.04 unit decrease in budget share for Brazil and Pakistan, respectively. The positive sign of the total expenditure coefficient for Peru indicates that one unit increase in expenditure will result in a 0.09 unit increase in its budget share. This finding reveals that Peru's mango demand in the EU is increasing more compared to other countries. CBI (2009) also revealed that mango imports from extra-EU countries have experienced faster growth with a notable increase in mango imports from Peru. For price responses, the individual coefficients don't have the usual economic interpretation here; they will be discussed based on their estimated elasticities in the subsequent results.

The expenditure and price elasticities estimates have been constructed from the parameters explained above. As discussed earlier, expenditure elasticity measures the responsiveness of the quantity demanded of a good to changes in the total expenditure (income) of the consumer (importer in this case), it indicates whether a good is normal (positive elasticity) or inferior (negative elasticity) based on changes in income. Marshallian elasticities contain both the income and price effects whereas for Hicksian elasticities, income effect is compensated away.

It can be observed from the estimates (Table 7.3), that the expenditure elasticities for Brazil, Peru, Cote d'Ivoire, and ROW are found statistically significant while Israel and Pakistan are found to be insignificant. The expenditure elasticity coefficient for Peru, greater than one with a positive sign (1.38) implies that there is a tendency for mango imports from Peru to be particularly favored over other countries when total expenditure on mango imports grows in the EU. A 1% increase in total expenditure will lead to an approximate 1.38% increase in the quantity of mango imported from Peru. Similarly, the elasticity coefficient for the ROW (1.27) indicates that a 1% increase in total expenditure will lead to an approximate 1.27% increase in the quantity of mango imported from ROW. It also shows that in the future, the EU will be looking to explore new sources of mango import along with its current major supplying countries. Though significant but less than ROW, the coefficient values of Brazil (0.68) and Cote d'Ivoire (0.94) reveal that there will be a disproportionate increase in mango import from these two countries when EU total expenditure on mango import grows by 1%, holding relatives' prices constant.

Despite not being significant, a positive coefficient value for Israel (0.74) means that a 1% increase in total expenditure will lead to an approximate 0.74% increase in the quantity of mango imported from Israel. Conversely, expenditure elasticity for Pakistan, less than one with a negative sign (-0.22), suggests that 1% increase in EU mango import expenditure will result in a 0.22% decrease in quantity imported from Pakistan. Keeping relative import prices constant for each country, there could be several reasons for these results as expenditure elasticities may evolve from non-price factors also, such as product quality, sanitary and phyto-sanitary measures, reliability in timely supply, trade contracts, and marketing & promotion activities, etc., (SATYANARAYANA et al., 1999; SILVERWOOD, 2015).

Table 7.3: Expenditure elasticities of extra-EU exporters

Countries	Expenditure elasticities
Brazil	0.68 (0.11)***
Peru	1.38 (0.09)***
Israel	0.74 (0.46)
Cote d'Ivoire	0.94 (0.40)**
Pakistan	-0.22 (0.71)
Rest of the world	1.27 (0.19)***

Note: *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively. Numbers in the brackets are standard errors.
Source: Author's estimations

Next to the expenditure elasticities, the Marshallian price elasticities of demand for extra-EU countries are discussed (Table 7.4). All own-price elasticities (highlighted in bold) are negative as expected, although only Cote d'Ivoire is statistically significant. For own-price elasticity of demand; Peru, Code d'Ivoire, and Pakistan are found elastic (>1) which means, a 1% increase in their prices will respectively result in more than a 1% decrease in the quantity demanded from these countries. It is worth noting that Pakistan is observed as a highly price-sensitive country with a value (-2.47), resulting in a 2.47% decrease in quantity demand with a 1% increase in its price. Other countries like Brazil, Israel, and ROW category are found inelastic (<1) which means, the response to their own-price change as quantity demanded from these countries is disproportional e.g., a 1% increase in ROW mango price will result in a 0.60% decrease in its quantity demanded.

The competitive relationship among suppliers can be observed through their cross-price elasticities. Positive cross-price elasticities show that the mangoes imported from different countries are substitutes while negative cross-price elasticities indicate they are complements. It is also interesting to see that two pairs of countries' cross-price elasticities are found significant viz; Brazil with Peru and Israel with ROW, and their negative signs indicate that the mango imported from these countries exhibit complementary relation for each other. The cross-price elasticity of Brazil to Peru (-0.17) shows a weak complementary relationship between them while the cross-price elasticity of Peru to Brazil (-0.48) shows a fairly strong complementary relationship between them. Conversely, the non-significant but positive cross-price elasticity of Pakistan to Peru (2.23) and Israel to Peru (1.33) showed a strong substitution relationship of Pakistan and Israel mango for Peru, meaning Israel and Pakistan can enhance their mango export shares by improving their quality.

Table 7.4: Marshallian (uncompensated) price elasticities of extra-EU exporters

Countries	Brazil	Peru	Israel	Cote d'Ivoire	Pakistan	ROW
Brazil	**-0.83** **(0.47)**	-0.17*** (0.23)	0.07 (0.14)	0.01 (0.12)	-0.003 (0.19)	0.23 (0.38)
Peru	-0.48*** (0.35)	**-1.01** **(0.39)**	0.24 (0.22)	-0.02 (0.16)	0.26 (0.22)	-0.39 (0.43)
Israel	0.48 (1.09)	1.33 (0.99)	**-0.86** **(0.76)**	-0.08 (0.38)	0.06 (0.72)	-1.71* (1.09)
Cote d'Ivoire	0.03 (1.02)	-0.02 (0.79)	-0.10 (0.43)	**-1.17***** **(0.38)**	0.13 (0.63)	0.19 (0.81)
Pakistan	0.28 (1.90)	2.23 (1.38)	0.14 (0.99)	0.22 (0.75)	**-2.47** **(1.77)**	-0.16 (2.27)
ROW	0.10 (0.57)	-0.35 (0.36)	-0.35* (0.22)	0.02 (0.14)	-0.07 (0.33)	**-0.60** **(0.59)**

Note: *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively. Numbers in the brackets are standard errors.
Source: Author's estimations

In the same line of interpretation of Marshallian elasticities, Hiscksian own-price, and cross-price elasticities of demand can also be explained (Table 7.5). As expected, all Hicksian own-price elasticities (highlighted in bold) are found negative with varying degrees of response to each country's price change. It was noted that Hicksian own-price elasticity results are found similar to Marshallian own-price elasticities. For example, Brazil and Pakistan with their Hicksian own-price elasticities of (-0.59) and (-2.49), are the same countries in the Marshallian case too which showed the lowest and highest own-price elasticities by being weak price inelastic and highly price elastic, respectively.

In the case of Hicksian cross-price elasticities also, it was interesting to note that the results are found in matching to Marshallian cross-price elasticities. For example, Brazil to Peru and Peru to Brazil both showed complementary relations for each other's product, though with a fairly weak degree of relationship compared to Marshallian cross-price elasticities.

Table 7.5: Hicksian (compensated) price elasticities of extra-EU exporters

Countries	Brazil	Peru	Israel	Cote d'Ivoire	Pakistan	ROW
Brazil	**-0.59** **(0.44)**	-0.001** (0.25)	0.11 (0.14)	0.05 (0.13)	0.02 (0.19)	0.42 (0.40)
Peru	-0.002** (0.34)	**-0.65** **(0.41)**	0.32 (0.22)	0.04 (0.16)	-0.32 (0.22)	-0.03 (0.42)
Israel	0.73 (0.96)	1.56 (1.09)	**-0.82** **(0.75)**	-0.05 (0.39)	0.09 (0.70)	-1.52 (1.13)
Cote d'Ivoire	0.35 (0.91)	0.22 (0.88)	-0.05 (0.43)	**-1.13***** **(0.39)**	0.17 (0.61)	0.44 (0.85)
Pakistan	0.19 (1.74)	-2.17 (1.51)	0.13 (0.98)	0.21 (0.77)	**-2.49** **(1.75)**	-0.23 (2.37)
ROW	0.54 (0.52)	-0.02 (0.40)	-0.29 (0.21)	0.08 (0.14)	-0.003 (0.33)	**-0.26** **(0.62)**

Note: *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively. Numbers in the brackets are standard errors.
Source: Author's estimations

7.4.2 AIDS model estimations for intra-EU imports

This section aims to analyze the mango import demand of the EU from the fellow EU exporting countries, which are mainly re-exports of their extra-EU imports. In this analysis, it is attempted to quantify expenditure-based demand responses, assess the impact of price changes on mango consumption, and determining both Marshallian and Hicksian price elasticities of demand to provide a comprehensive understanding of the economic dynamics influencing mango import demand within the EU.

The summary statistics are presented in Table 7.6. Variations in the average export prices across intra-EU countries can be observed. For instance, the Netherlands and Belgium exhibit relatively stable prices, with the former ranging between 1.49 and 2.11 €/kg and the latter between 1.80 and 2.25 €/kg. In contrast, Spain and the

ROEU show slightly more fluctuation, with average prices ranging from 1.59 to 2.36 €/kg and 1.74 to 2.90 €/kg, respectively. In budget shares, a general pattern emerges where certain countries, such as the Netherlands, Spain, and Germany hold relatively larger budget shares, while others like France, Belgium, and the ROEU have smaller shares. Interestingly, Netherlands' budget share demonstrates a relatively high mean of 54.4%, indicating the largest contribution in intra-EU exports, compared to other countries. Meanwhile, total expenditure highlights substantial variation, with expenditures ranging from 0.18 to 0.61 (€ Million).

Table 7.6: Summary statistics of variables involved in LA/AIDS model for intra-EU exporters

Variables	Min	Max	Mean	Variance
Netherlands export price (€/kg)	1.49	2.11	1.84	0.04
Spain export price (€/kg)	1.59	2.36	2.02	0.07
Germany export price (€/kg)	1.35	2.49	2.02	0.11
France export price (€/kg)	1.01	2.29	1.90	0.10
Belgium export price (€/kg)	1.80	2.25	2.02	0.02
Rest of EU export price (€/kg)	1.74	2.90	2.34	0.09
Netherlands budget share (%)	52.03	62.39	54.40	7.61
Spain budget share (%)	11.98	20.75	16.93	6.31
Germany budget share (%)	6.16	10.19	8.38	1.84
France budget share (%)	4.36	14.57	6.82	7.88
Belgium budget share (%)	3.57	7.03	5.67	1.22
Rest of EU budget share (%)	4.35	9.55	7.62	2.49
Expenditure (€ million)	0.18	0.61	0.38	22694.96

Source: Author's calculations based on EUROSTAT database (2008-2020)

After defining the summary statistics, a bar chart representation of the total annual mango exports (ton) of intra-EU exporting countries has been discussed (Figure 7.4). It can be observed that the Netherlands and Spain consistently exhibit a pattern of steady growth in their total annual mango exports. Both countries started at relatively lower levels in 2008 but by 2020, they have significantly expanded their export volumes. Spain's exports, in particular, have shown notable growth, roughly doubling over the years. Germany's export trend is characterized by slower growth in early years before resuming an upward trajectory, since 2013.

France's export trend showcases a mix of ups and downs. After experiencing an initial dip, its exports increased up to 2016, followed by a slight decline again in subsequent years. Belgium's exports appear to follow a relatively stable pattern with moderate growth, while the ROEU displays a somewhat similar trajectory.

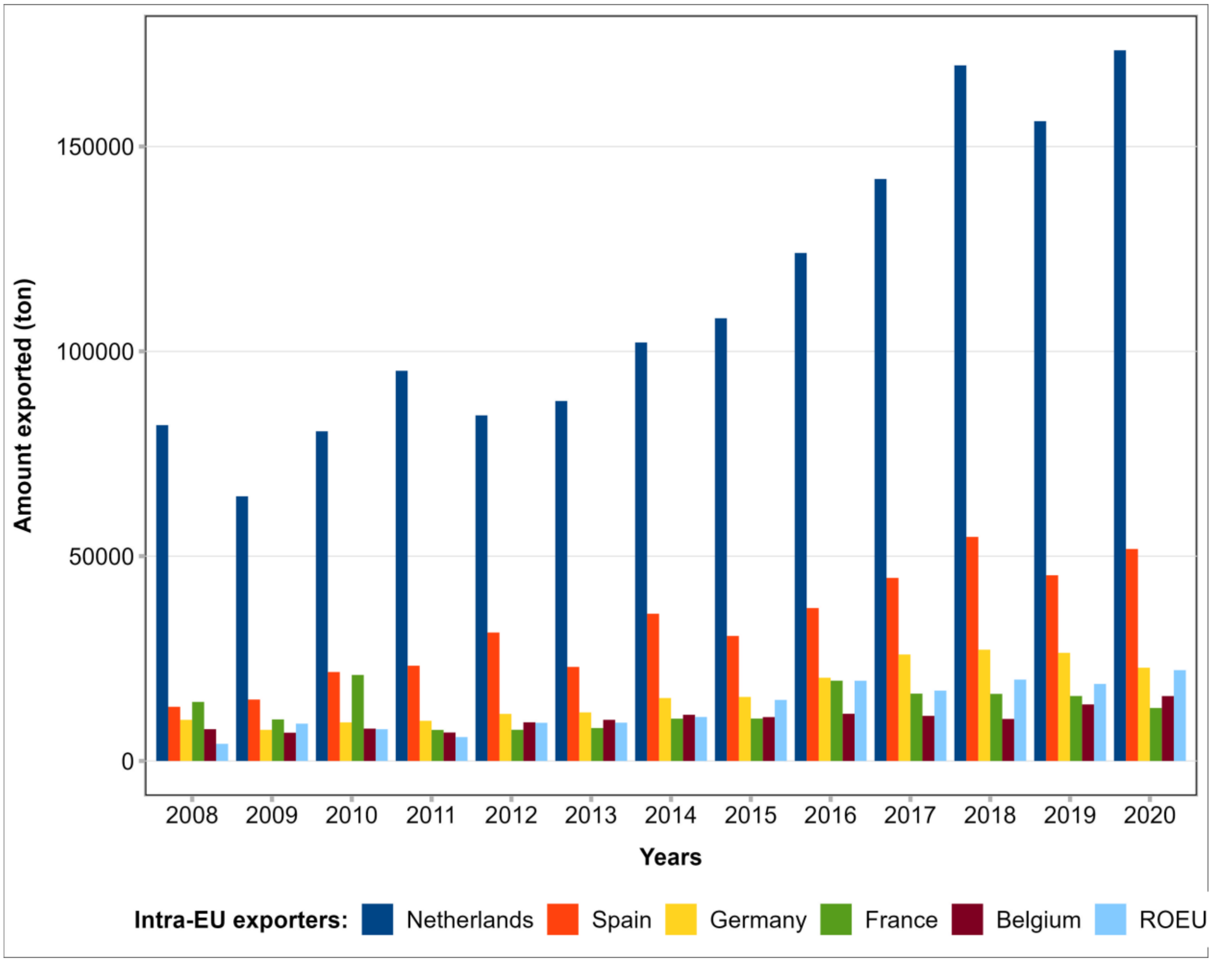

Figure 7.4: Total annual mango exports of intra-EU countries (2008-2020)

Source: Author's illustration based on EUROSTAT data (2020)

The annual proportion of market share (%) by quantity of intra-EU countries has been presented in Figure 7.5. Despite some fluctuations, the Netherlands has maintained the highest market share throughout the years, reflecting its consistent and dominant role in EU mango trading. Spain's market share exhibited noticeable growth, expanding from around 10% to approximately 18% over the years, showing its increasing prominence and ability to capture 2nd largest share of mango exports within the EU. Germany holds a relatively stable market share, ranging between 6% and 10%, although it experiences minor fluctuations. This steadiness indicates Germany's consistent presence in the EU mango export market without significant shifts. France's market share follows a varied trajectory, fluctuating between 4% and 9% while Belgium's market share ranges from approximately 4% to 6%. The ROEU category displays a relatively stable market share, around 5% to 8%.

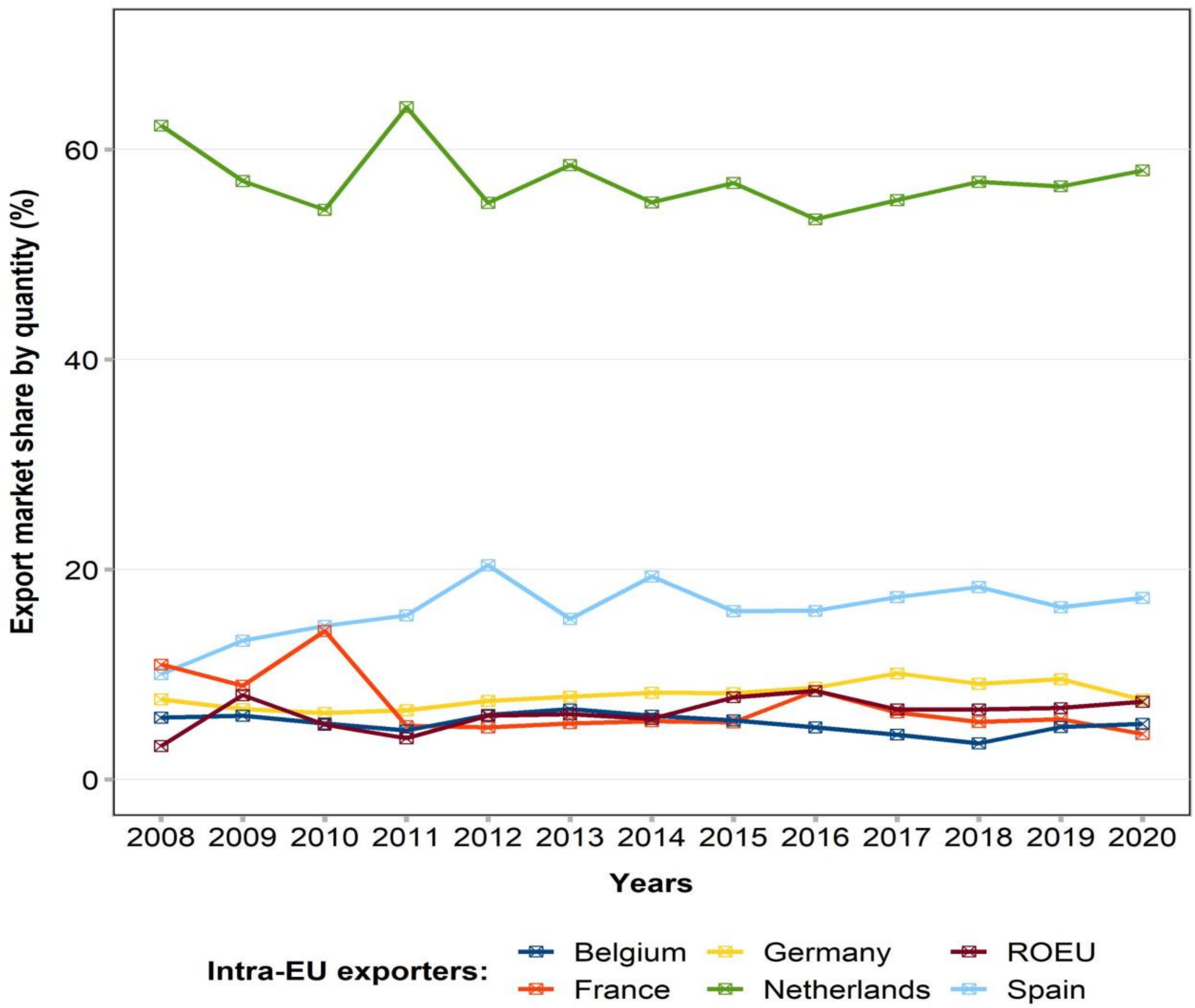

Figure 7.5: Export market share of intra-EU countries by quantity (2008-2020)

Source: Author's illustration based on EUROSTAT data (2020)

The annual mango export market share (%) by value of the intra-EU exporters is presented in Figure 7.6. The Netherlands has maintained the highest market share throughout the years, ranging from approximately 52% to 62% reflecting the country's persistent dominance in the market by value also. Spain's market share by value exhibits a noticeable increase, growing from 11% to approximately 20% over the years. This upward trend aligns with the previous finding of Spain's growing market share by volume, emphasizing its overall expanding role in the EU market.

Germany's market share by value remains relatively stable, ranging between 6% and 10%, similar to its trend observed in the analysis of market share by volume. France's market share by value also displays fluctuations between 5% and 10%, aligning with the volatility observed in its market share by volume. Belgium's market share by value remains relatively consistent, ranging from approximately 4% to 6%, akin to the stable trend observed in its market share by volume. Overall, it can be concluded that the Netherlands, Spain, and Germany consistently hold prominent positions in intra-EU mango trading, in both, volume and value terms.

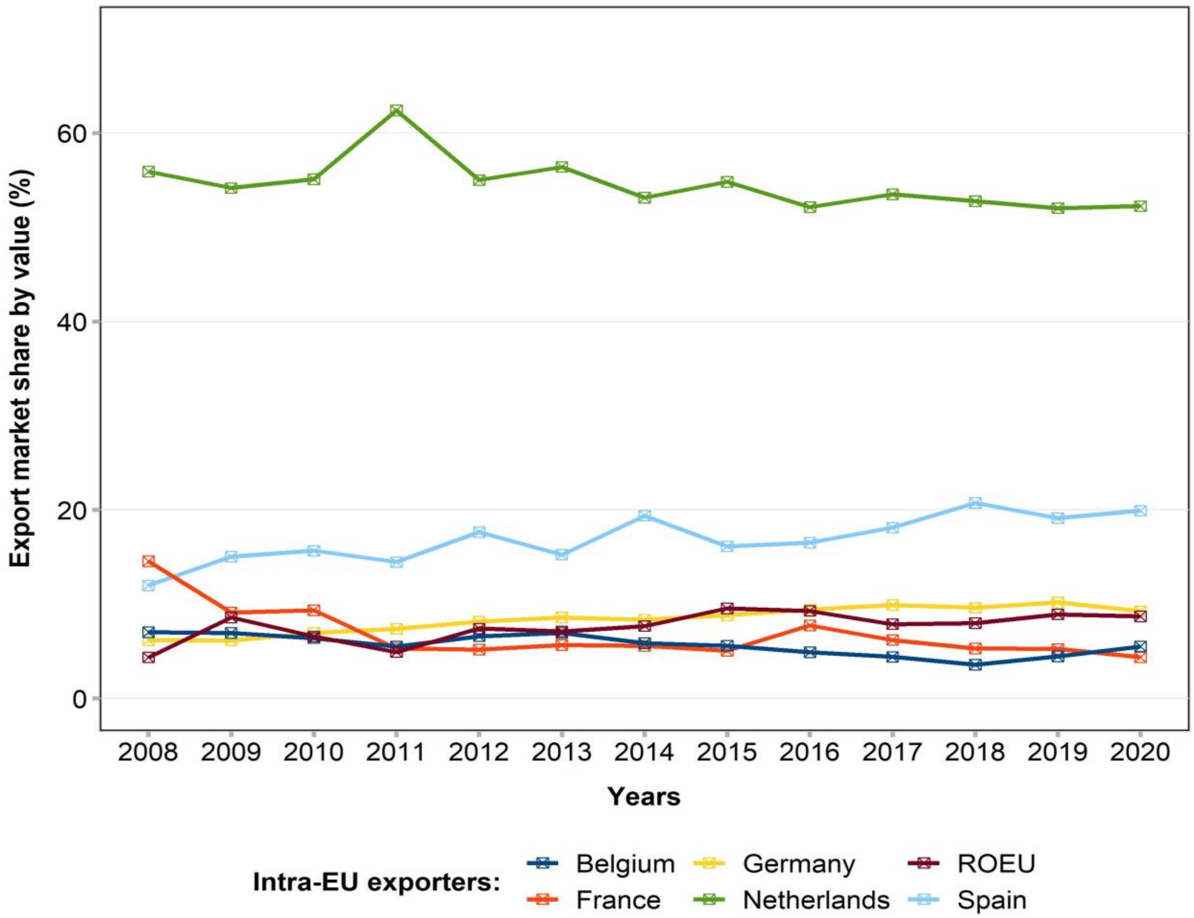

Figure 7.6: Export market share of intra-EU countries by value (2008-2020)

Source: Author's illustration based on EUROSTAT data (2020)

In the subsequent section, the estimations of the LA/AIDS model (see Table 7.7) for intra-EU mango imports are discussed. For theoretical validation, coefficients' restrictions of adding-up, homogeneity, and symmetry are imposed during model estimation. The coefficients associated with total expenditure (income) are found statistically significant for all countries except Belgium and the ROEU. These coefficients denote the effect of change in importing countries' income on the budget share gained by the supplying countries. Negative expenditure coefficients for the Netherlands (-0.06) and France (-0.04) suggest that one unit increase in their income will result in 0.05% and 0.04% decrease in their budget shares, respectively. On the contrary, the positive coefficients for Spain and Germany reveal that with a one-unit increase in total expenditure, there will be a 0.06% and 0.04% increase in their budget share, respectively. Based on these findings, it can be concluded that, over time Spain and Germany are gaining more share and becoming important mango-supplying countries within the EU. The price coefficients indicate the influence of price changes on a country's own or other country's quantity demanded of mango. However, responses for price change will be discussed in detail with their elasticity estimates, which are given subsequently.

Table 7.7: Estimated coefficients of LA/AIDS model for intra-EU exporters

Price \ Budget Share	Netherlands	Spain	Germany	France	Belgium	ROEU
Netherlands	-0.17* (0.09)	-0.04 (0.05)	0.09* (0.05)	-0.03 (0.04)	0.04 (0.05)	0.11** (0.05)
Spain	-0.04 (0.05)	-0.03 (0.05)	0.01 (0.03)	0.03 (0.03)	0.003 (0.03)	0.04 (0.04)
Germany	0.09** (0.05)	0.01 (0.03)	-0.04 (0.04)	-0.03 (0.02)	-0.02 (0.03)	-0.01 (0.03)
France	-0.03 (0.04)	0.04 (0.04)	-0.02 (0.02)	0.001 (0.04)	0.01 (0.02)	0.01 (0.026)
Belgium	0.05 (0.05)	0.003 (0.03)	-0.02 (0.03)	0.01 (0.02)	0.001 (0.05)	-0.05 (0.03)
ROEU	0.11** (0.05)	0.03 (0.03)	-0.01 (0.03)	0.01 (0.04)	-0.04 (0.03)	-0.09** (0.49)
Total expenditure	-0.06** (0.02)	0.06*** (0.02)	0.04** (0.02)	-0.04* (0.02)	-0.02 (0.01)	0.02 (0.02)
Constant	1.25*** (0.30)	-0.64** (0.27)	-0.39* (0.20)	0.59** (0.29)	0.36* (0.18)	-0.17 (0.19)
R-square	0.99	0.96	0.97	0.55	0.61	0.94

Note: *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively. Numbers in the brackets are standard errors.
Source: Author's estimations

As already discussed, expenditure elasticity measures the responsiveness of the quantity demanded of a good to changes in the total expenditure of the importing countries (consumers). Expenditure elasticities were found positive for all the intra-EU countries which show that mango is traded as a normal good (Table 7.8). It can be noted that expenditure elasticities for Spain, Germany, and ROEU are above one and also found statistically significant, which means they are income-elastic countries e.g., one unit increase in consumers' (importers) income will cause more than a 1% increase in the quantity demanded from these countries.

For the Netherlands, an increase of 1% in total expenditure leads to an approx. 0.89% increase in the quantity demanded from it. The elasticity of 1.36 for Spain indicates that a 1% increase in total expenditure is associated with 1.36% increase in the quantity demanded from it. Similarly, German mango imports are responsive to changes in expenditure, with an elasticity of 1.45, implying it is a normal good. For France, the relatively low elasticity (0.35) indicates that French mango imports are inelastic to changes in expenditure. The expenditure elasticity of Belgian mango imports (0.58) also points towards in-elasticity, though less than France. Mango imports from the ROEU exhibit normal good behavior, with an elasticity of 1.28.

Table 7.8: Expenditure elasticities for intra-EU exporters

Countries	Expenditure elasticities
Netherlands	0.89 (0.04)***
Spain	1.36 (0.12)***
Germany	1.45 (0.19)***
France	0.35 (0.35)
Belgium	0.58 (0.26)**
ROEU	1.28 (0.19)***

Note: *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively. Numbers in the brackets are standard errors.
Source: Author's estimations

From Marshallian price elasticities (Table 7.9), the Netherlands' own-price elasticity indicates a relatively elastic response e.g., a 1% increase in its mango import price leads to 1.16% decrease in its quantity demanded, suggesting that consumers are sensitive to price changes and reduce their consumption accordingly. CBI (2009) also justified that although mangoes are available all year round in Netherland's supermarkets, but high prices can cause slow-down the consumption of mangoes.

Spain's own-price elasticity suggests that a 1% increase in the price of Spanish mango imports leads to a 0.96% decrease in the quantity demanded, implying slightly inelastic demand. For Germany, a 1% increase in the price of mango imports results in a 1.31% decrease in the quantity demanded, indicating a relatively elastic response. Report from CBI (2009) supports finding, indicating that high prices for mangoes, coupled with a substantial supply of summer fruits, resulted in a decreased demand and a drop in sales in Germany during the 2008 season. Similarly, the negative own price elasticities for France and Belgium suggest that a 1% increase in their mango import prices leads to a 0.58% and 0.84% decrease in their quantity demanded, respectively. The own-price elasticity for the ROEU implies that a 1% increase in the price of these imports leads to a 2.16% decrease in the quantity demanded, indicating a highly elastic response.

Negative cross-price elasticity between two countries' imports indicates that their products are complementary to each other. For example, the negative cross-price elasticity of -0.58 between the Germany and France suggests that a unit increase in the Germany's mango price can cause a relative decrease in mango import from France. Positive cross-price elasticity implies that the goods are substitutes. The positive cross-price elasticity of 0.17 between the Netherlands and ROEU indicates that these two sources of imports are substitute goods, meaning that an increase in the price of one may lead to an increase in demand for the other country's good.

Table 7.9: Marshallian (uncompensated) price elasticities for intra-EU exporters

Countries	Netherlands	Spain	Germany	France	Belgium	ROEU
Netherlands	**-1.16*** (0.19)**	-0.15 (0.09)	0.12 (0.08)	0.01 (0.07)	0.12 (0.09)	0.17** (0.09)
Spain	-0.71*** (0.32)	**-0.96** (0.29)**	0.20 (0.16)	-0.06 (0.22)	-0.11 (0.15)	0.27 (0.18)
Germany	0.48 (0.54)	0.39 (0.33)	**-1.31*** (0.39)**	-0.58* (0.30)	-0.37 (0.30)	-0.07 (0.32)
France	0.39 (0.71)	0.02 (0.56)	-0.67* (0.38)	**-0.58 (0.71)**	0.41 (0.33)	0.08 (0.40)
Belgium	1.39 (0.98)	-0.19 (0.98)	-0.51 (0.48)	0.47 (0.39)	**-0.84 (0.79)**	-0.89 (0.57)
ROEU	0.99 (0.69)	0.61 (0.32)	-0.06 (0.36)	0.01 (0.43)	-0.67 (0.40)	**-2.16*** (0.59)**

Note: *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively. Numbers in the brackets are standard errors.
Source: Author's estimations

The Hicksian own-price elasticities (Table 7.10) consider the consumer's ability to adjust their consumption to maintain a constant level of utility when prices change. The negative elasticity for the Netherlands suggests that if the price of Dutch mango imports increases by 1%, consumers would reduce their consumption by approximately 0.69% while maintaining their desired utility. Similar results can be interpreted for Spain, France, and Belgium with respect to their own-price negative elasticities. However, German and ROEU consumers are found more sensitive to price changes as a 1% increase in their respective own prices results in a 1.18% and 2.06% decrease in their consumption respectively while keeping utility constant.

The negative cross-price elasticity of mango imports between Belgium and ROEU (-0.85) suggests that consumers tend to substitute these two sources to maintain their desired utility, indicating a complementary relationship. The positive cross-price elasticity for mango imports between Belgium and the Netherlands (1.71) indicates that the imports from these two sources are highly substitutes for each other while consumers maintain utility. An increase in the price of imports from one country may lead to an increase in demand for imports from the other country.

Table 7.10: Hicksian (compensated) price elasticities for intra-EU exporters

Countries	Netherlands	Spain	Germany	France	Belgium	ROEU
Netherlands	**-0.69*** (0.18)**	0.01 (0.09)	0.20** (0.08)	0.07 (0.07)	0.17* (0.09)	0.24** (0.09)
Spain	0.03 (0.29)	**-0.72** (0.30)**	0.32* (0.16)	0.03 (0.22)	-0.03 (0.15)	0.37* (0.19)
Germany	1.27** (0.54)	0.65* (0.33)	**-1.18*** (0.39)**	-0.49 (0.30)	-0.29 (0.30)	0.05 (0.33)
France	0.58 (0.61)	0.08 (0.58)	-0.64 (0.39)	**-0.56 (0.70)**	0.43 (0.32)	0.11 (0.41)
Belgium	1.71* (0.94)	-0.09 (0.47)	-0.46 (0.47)	0.51 (0.38)	**-0.81 (0.80)**	-0.85* (0.57)
ROEU	1.69** (0.66)	0.84* (0.42)	0.05 (0.36)	0.09 (0.34)	-0.60 (0.40)	**-2.06*** (0.59)**

Note: *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively. Numbers in the brackets are standard errors.
Source: Author's estimations

7.4.3 Export Competitiveness Analysis

To understand the extent and potential of Pakistan's mango exports to the European market, the study of comparative advantage is of paramount importance. The concept of competitiveness by using trade data under prevailing factors or product market distortions can approximate a country's comparative advantage (or disadvantage) in a particular commodity. A review of the existing literature on comparative advantage reveals that most of the analytical work on export competitiveness lacked the focus on EU market. The objective of this section is to analyze the shifting patterns in the comparative advantage of Pakistan's mango exports to the EU market over time, and its implications for export growth by comparing against major mango exporters. In order to examine the degree of competitiveness among the leading extra-EU mango suppliers, their export competitiveness indices are discussed. For this purpose, four different export indices; revealed comparative advantage (RCA), in-version revealed comparative advantage (lnRCA), revealed symmetric comparative advantage (RSCA) and comparative export performance (CEP) for each country are calculated.

Average RCA values of each country showing its competitive position for mango exports in the EU market are presented in (Figure 7.7). Peru demonstrates an exceptionally strong comparative advantage in mango trade over rest of the competitors, making it the most competitive mango exporter in the EU market. Similarly, Cote d'Ivoire's average RCA also suggests a strong comparative advantage in its mango exports in the EU market. SANGHO et al., (2010), while elaborating the reasons of Côte d'Ivoire's competitive edge over Brazil, Pakistan, and Israel, discussed that it has successfully gained a substantial portion of the sea-freight market for mango in the EU as it's exporters acquire mangoes directly from Malian buying agents and utilize packhouses located near the border to reduce transportation costs. This approach has led to a significant increase in the export of Ivorian mangoes.

Next to Peru, Brazil is observed exhibiting strong comparative advantage in mango exports among the rest of the extra-EU exporters. However, FAVERET FILHO et al., (2008) associated the reason of Brazil having low comparative advantage over Peru with the lack of success in establishing efficient commercialization systems. These systems are seen as outcomes of initiatives from both the public and private sectors, albeit in different combinations. Moreover, the Brazilian export market, which is relatively under-developed, faces challenges associated with certifications that adversely impact its ability to export to international markets (DORR & GROTE, 2009).

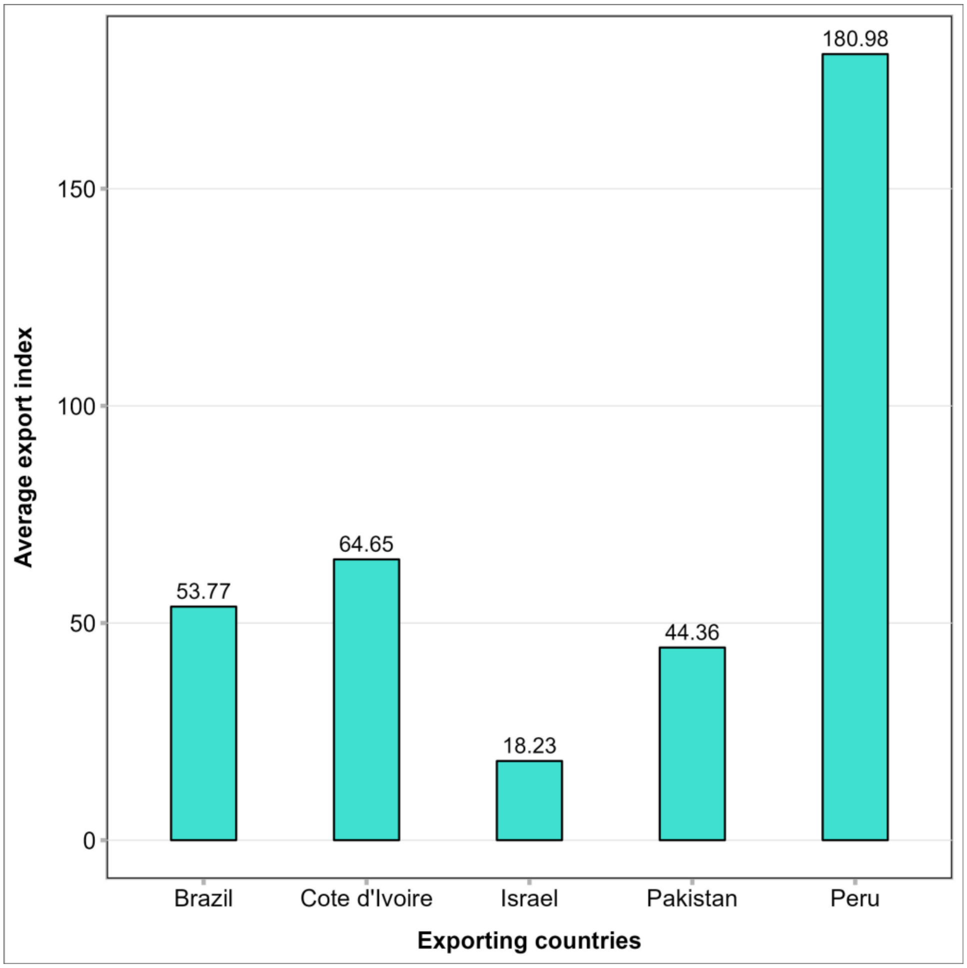

Figure 7.7: Export index of revealed comparative advantage

Source: Author's illustration based on WITS database (2008-2020)

Pakistan holds a competitive advantage over Israel in its mango exports to the EU, referring the potential for further growth in this market. However, it is found less competitive when compared to Peru, Brazil and Cote d'Ivoire. ABBAS et al., (2019) emphasized that to achieve success in the EU market, Pakistan mango exporters must establish a competitive edge over Brazilian & Peruvian mangoes and address supply volatility as it has the potential to expand its market share in the EU market through consistent supply. Developing trade capacity is crucial to fulfilling a steady export commitment despite the fluctuations in supply. Due to the decline in comparative advantage of Pakistani mangoes, HASSAN & REHMAN (2015) also emphasized that there is an urgent need to meet quality requirements of international markets to increase mango exports. Lastly, while not as pronounced as other countries, Israel's average RCA indicates its ability to utilize future opportunities for mango exports and strengthen its competitive position in the EU market.

The ln-version revealed comparative advantage (lnRCA) results offer similar highlights into the comparative advantage of major mango-exporting countries to the EU. Peru and Brazil, which had notably high average RCA values, maintain their positions of strength in the lnRCA export index, with lnRCA values of 5.15 and 3.98, respectively. Meanwhile Israel and Cote d'Ivoire also maintain their positions with lnRCA values of 2.88 and 4.16, respectively. These results align with their prior indications of strength in the mango trade. Pakistan, with a moderate average RCA value, shows a similar pattern in lnRCA, further confirming its competitive presence with an lnRCA of 3.59. AHMAD et al., (2021) suggested that, there is a pressing need to boost the exports of fruits because it can contribute to reduce the trade deficit, and augment the foreign exchange reserves.

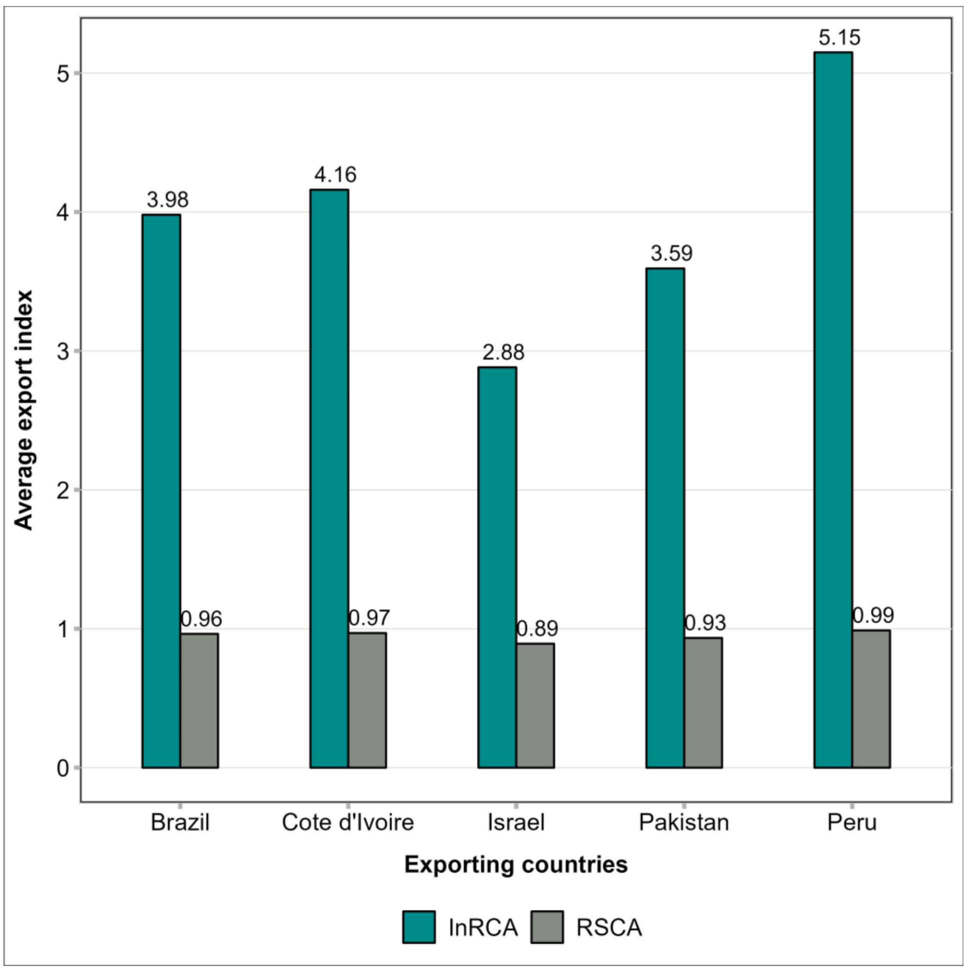

Figure 7.8: Export index of ln-version revealed comparative advantage and revealed symmetric comparative advantage

Source: Author's illustration based on WITS database (2008-2020)

The results of export index RSCA shed light on the symmetry and stability of comparative advantages in mango export among major exporting countries. Peru, similar to its strong RCA index, maintains its position with an average RSCA of 0.99, indicating a nearly balanced and stable competitive advantage. Brazil also showcases balanced competitiveness with a RSCA of 0.96. Israel and Cote d'Ivoire both demonstrating competitive advantages in the average RCA export index, exhibit symmetric competitiveness with RSCA values of 0.89 and 0.97, respectively. Pakistan, which displayed a moderate comparative advantage in the average RCA, demonstrates similarly balanced competitiveness with a RSCA of 0.93. The yearly-based decomposition of average RCA, InRCA, and RSCA indices is presented in Appendix 13.

The comparative export performance (CEP) index computed for Pakistan in relation to other leading countries is provided in Table 7.11. It can be observed that in recent years, the competitiveness of Pakistan with other countries has declined drastically. One of the major reasons for this decline may be associated with Pakistan’s non-compliance of sanitary and phyto-sanitary standards in exports to the EU.

Table 7.11: Comparative export performance index (CEP) values

Year	Pakistan-Brazil	Pakistan-Peru	Pakistan-Israel	Pakistan-Cote d’Ivoire
2008	1.66	0.60	2.95	1.13
2009	1.58	0.69	3.60	1.35
2010	1.14	0.48	3.50	1.16
2011	1.41	0.52	2.97	1.05
2012	1.54	0.60	3.83	1.03
2013	1.16	0.34	3.63	0.80
2014	0.33	0.12	1.08	0.23
2015	0.40	0.12	1.60	0.44
2016	0.51	0.14	1.53	0.40
2017	0.37	0.10	1.19	0.35
2018	0.54	0.12	1.93	0.41
2019	0.46	0.12	1.89	0.47
2020	0.14	0.03	0.59	0.15
$\overline{CEP}$	0.87	0.31	2.33	0.69

Note: The $\overline{CEP}$ indicates average values.
Source: Author’s calculations based on WITS database (2008-2020)

Additionally, average CEP values are also confirming the temporal decline, except for Israel. With Pakistan-Brazil, Pakistan does not hold a competitive advantage over Brazil. As CEP value falls below 1, it suggests that Brazil has a stronger competitive position in the mango trade compared to Pakistan. For Pakistan-Peru also, Pakistan does not possess a competitive advantage over Peru in mango exports. The CEP value is well below 1, indicating that rather Peru maintains competitive edge over Pakistan in the mango exporting sector. Similar to its situation with Brazil and Peru, Pakistan does not hold a competitive advantage over Cote d'Ivoire in mango exports. In the case of Pakistan-Israel, Pakistan demonstrates a considerable competitive advantage over Israel. Moreover, a graphical illustration of average CEP values is given in Appendix 14.

7.5 Summary and conclusion

This chapter undertook a meticulous import demand and export competitiveness analysis of mango within the EU. Firstly, to evaluate import demand for extra-EU exporters, LA/AIDS model is estimated. It presented significant coefficients related to total expenditure (income) for Brazil, Peru, and Pakistan. For these countries, an increase in total expenditure of the importing EU countries is found associated with a decrease in budget share for Brazil and Pakistan, while it led to an increase in budget share for Peru. This finding highlights Peru's increasing mango demand in the EU compared to other extra-EU countries, suggesting its favorable position in the market. Notably, expenditure elasticities for Brazil, Peru, Cote d'Ivoire, and the ROW are found statistically significant. Among these, both Peru and ROW exhibited expenditure elasticities greater than one, signifying their growing prominence as mango suppliers in the EU.

Subsequently, the analysis explored price responses in terms of their elasticities, focusing on both Marshallian and Hicksian perspectives. Own-price elasticities are found to be negative, as expected. Countries like Peru, Cote d'Ivoire, and Pakistan show own-price elasticities greater than one, indicating a decrease in the quantity demanded with an increase in their own-prices. For Brazil, Israel, and ROW, own-price elasticities are inelastic, implying a relatively smaller change in quantity demanded in response to their own-price fluctuations. Cross-price elasticities uncovered insightful patterns of substitution and complementarity among mango-exporting countries. Notably, Brazil and Peru exhibited a complementary relationship in their products, whereas Israel and ROW also displayed similar dynamics. This complementarity presents opportunities for enhancing mango export revenues. The Hicksian own-price and cross-price elasticities mirrored the Marshallian results, reinforcing the findings observed in both cases.

In the subsequent section, the analysis transitioned to the application of LA/AIDS for intra-EU exports. The coefficients associated with total expenditure emerged as statistically significant for all countries, except for Belgium and the ROEU. Netherlands and France displayed negative expenditure coefficients, suggesting that a unit increase in income of importing countries results in a decrease in their budget share. Conversely, Spain and Germany exhibited positive expenditure coefficients, indicating that an increase in total expenditure corresponded with an increase in their budget share. This highlights the growing importance of Spain and Germany as mango-supplying countries within the EU.

Furthermore, an exploration of expenditure and price elasticities for intra-EU import demand reveals notable findings. All countries exhibited positive expenditure elasticities, indicating that mango is treated as a normal good, meaning, consumers' income growth leads to a more than 1% increase in quantity demanded. The Netherlands, Spain, and Germany displayed income-elastic characteristics, with consumers being relatively more responsive to changes in expenditure, while France and Belgium showed income-inelastic behavior. Moving to the price elasticity, the Netherlands displayed relatively elastic own-price elasticity, meaning a 1% increase in the price of Dutch mango exports corresponds with a 1.17% decrease in its quantity demanded. In contrast, Spain and Germany showed inelastic own-price elasticity. The Netherlands and Spain exhibited negative cross-price elasticity, suggesting consumer preference for one source over the other based on relative prices, reflecting a complementary relationship between them. In contrast, positive cross-price elasticity for mango imports between the Netherlands and Germany indicates substitutability among these sources.

Hicksian own-price elasticities reiterated the consumers' sensitivity to price changes, with varying degrees of response. Belgium displayed a high Hicksian own price elasticity, indicating that a 1% price increase in its product would lead to a substantial 0.80% reduction in consumption while maintaining utility. The ROEU exhibited a highly inelastic response, with a 1% price increase in their export price resulting in a substantial 2.06% reduction in consumption while maintaining utility. The cross-price elasticity between Belgium and the ROEU indicates a complementary relationship. Conversely, the cross-price elasticity for mango imports between Belgium and the Netherlands points to a strong substitution between these supply sources while maintaining utility.

After the LA/AIDS model estimation, the competitive positions of extra-EU mango-supplying countries in the EU market are examined by using the different export competitiveness indices. Brazil’s average RCA value (53.77) exhibits a robust comparative advantage, revealing its significance in mango exports to the EU. Peru displayed an exceptionally strong competitive edge (average RCA 180.98), solidifying its position as one of the leading mango exporters. Israel, with an average RCA of 18.23, indicates its potential to specialize in mango trading and maintain competitiveness. Cote d’Ivoire's average RCA (64.65) showcased a noteworthy comparative advantage in mango exports to the EU market. Pakistan, with an average RCA of 44.36, demonstrated a moderate comparative advantage, signifying a consistent presence in the EU and potential for further growth and specialization.

The lnRCA results confirm these findings i.e., Peru and Brazil, with notably high average RCA values, maintained their competitive positions in the lnRCA export index also. Israel and Cote d’Ivoire, which also displayed competitive advantages in the average RCA, preserved their positions with strong lnRCA values. Pakistan's moderate average RCA value translated into a similar pattern in lnRCA, underlining its competitive presence. The export index of RSCA provided insights into the symmetry and stability of comparative advantages. Peru, Brazil, Israel, Cote d'Ivoire, and Pakistan showcased balanced and stable competitive advantages, underlining their well-rounded positions in the mango trade.

The CEP index, which compared Pakistan's competitive advantage to its four competitor countries in the market, reveals a nuanced landscape. Pakistan did not hold a competitive advantage over Brazil and Peru, indicating these countries' stronger positions in mango exports. However, Pakistan demonstrated a significant competitive edge over Israel, while it did not possess a competitive advantage over Cote d’Ivoire also. These results offer a comprehensive view of Pakistan's competitive standing in mango exports compared to its major competitors in the EU market.

8 SUMMARY, CONCLUSION AND RECOMMENDATIONS

This last chapter describes in general the study's summary, conclusion and research methodologies used for results estimations. It summarizes the export performance and profitability of Pakistan mango exporting firms, focusing on their business efficiency and factors influencing it. It extends to the brief discussion of profit margins obtained in different export markets and how the firms' socio-economic characteristics & cost-related factors affect this margin. It also scrutinizes the transport mode preferences of exporters in order to maximize the profit. Lastly, the major findings from the EU import demand and competitive analysis of Pakistan with leading mango suppliers in this market, is provided. The chapter concludes with the empirical findings, policy recommendations and highlighting the areas for future research while acknowledging the study's limitations.

8.1 Summary and conclusion

8.1.1 Estimation methods

This study involved Pakistan mango exporting firms operating in the provinces of Punjab and Sindh. The research predominantly relied on primary data collected through direct interviews of 100 mango exporting firms in 2014. In addition to this, focus group discussions and key informant interviews were also conducted to gain insights into exporters' perceptions regarding transport attributes encountered during the export process. In order to complement the primary data, secondary data was also retrieved from the online databases, to conduct import demand analysis and the export competitiveness among leading mango exporting countries for the EU market. By using this primary and secondary data, exporters' demographics, socio-economic characteristics, firms' export activities, and cost-related factors are examined.

The analyses begin with utilizing data envelopment analysis, where export markets were categorized into Aggregate, Specialized–EU, Diversified–EU, and Diversified–non-EU exports. By using the input-oriented variable return-to-scale model, DEA was employed for each market to assess the export efficiency of the selected firms exporting to that respective market. The estimated efficiency scores from DEA served as a pivotal foundation for subsequent regression analysis. The analysis delved further into the determinants influencing the export efficiency, providing highlights into market-specific export dynamics.

However, own-price elasticities for Brazil and Israel were found inelastic. It was also noted that Brazil and Peru exhibit a complementary relation in their trade.

Focusing on intra-EU exports, all countries exhibited significant total expenditure coefficients, except for Belgium. Netherlands and France displayed negative while Spain and Germany exhibited positive expenditure coefficients. This suggested that there is a growing importance of Spain and Germany as mango-suppliers within the EU. Additional observation was made as mango being a normal good for all the intra-EU countries, meaning, consumers' income growth leads to a more than 1% increase in its quantity demand. The Netherlands, Spain, and Germany were more responsive towards changes in expenditure, while France and Belgium showed income-inelastic behavior. Moreover, the Netherlands displayed elastic own-price elasticity while Spain and Germany showed inelastic own-price elasticities. A complementary relation of mango import between major intra-EU supply sources i.e., Netherlands and Spain, while substitutability of Netherlands with Germany and Belgium was identified.

In the estimations of export competitiveness of extra-EU mango suppliers to the EU market, consistent with the findings of import demand analysis, Peru displayed an exceptionally strong competitive advantage over rest of the exporting countries. Following this observation, Pakistan's competitive advantage to its four extra-EU competitors was considered. Pakistan was found to be operating less competitive in comparison with all of the extra-EU countries except for Israel. This pattern was consistent and in-line with EU import demand, which confirmed previous findings. It revealed that Pakistan does not hold a competitive advantage over Brazil, Peru, and Cote d'Ivoire in mango exports to the EU; however it presented a substantial competitive edge over Israel.

8.1.2 Major findings and conclusion

In the evaluation of firms' export efficiency and factors affecting it, for aggregate exports, it was observed that age (young exporters), high educational qualification, diversification in mango varieties and use of local packing materials contribute positively to export process. In this market, more than 80% of the firms were found to be operating at optimum efficient level, while securing net export margin 2.29 USD/kg. This led to important observation that cost factors incurred by exporters i.e. high international freight cost, purchase & production cost, and labor cost are influential in affecting the margin on large scale. Along with these factors, it was also observed that number of shipments and treatment type HWD, impact mango export quantity significantly.

In the Specialized–EU export market, similar factors were observed to influence firms' efficiency positively. However, the use of imported packing boxes' effect on efficiency was reported negatively. It revealed that as the use of imported packing boxes for EU exports are not mandatory, exporters can also use good quality local boxes, to enhance firms' efficiency. Furthermore, packaging costs along with high international freight cost, purchase & production cost, and labor cost were found to be major factors affecting export margin. Compared to aggregate market, a higher net export margin of 2.78 USD/kg was found for these exports.

In Diversified–EU exports, variables like early procurement, mixed packing boxes and hired treatment plant facility were identified to influence firms' efficiency positively, which means exporters should focus on these factors to enhance their export efficiency in this market. The net export margin in this market was found 2.65 USD/kg, while only 55% of sample firms achieved optimum efficiency. Cost variables highlighted in previous market, along with high number of shipments, mixed sources of initial supply and education underscored the positive impact on mango exports in this market.

The export margin analysis revealed that the Specialized–EU and Diversified–EU exports are characterized as high-value markets. It is observed that majority of the sampled exporters prefer the Diversified–EU, although Specialized–EU is identified as the most attractive market for mango exports primarily due to its high-profit margin, which suggests that adopting Specialized–EU export strategy maybe more beneficial for exporters. However, to achieve higher sale prices in this market, there is a need to streamline mango supply chain by rationalizing crucial average freight cost while improving product quality, simultaneously.

Exporters are found dissatisfied with high air transport costs for exports to EU. Sea transport, almost being five times cheaper than air transport, raised concerns about the risk of loss & damage during shipping. Air transport also faced higher dissatisfaction regarding freight capacity and offloading issues compared to sea transport. On the other hand, sea transport was found associated with higher perceived insurance issues while exporters considered air transport as having less concerns about freight insurance. Meanwhile, shipment track & trace also posed a challenge in sea transport but was not considered a significant issue in air transport by exporters. Addressing exporters' freight-related issues is essential for mangoes export growth. To mitigate problems stemming from freight capacity, flight delays and off-loading, regulations can be introduced to develop coordination among exporters, airlines' management and institutional authorities.

Discrete choice experiment revealed that attributes i.e., transport cost, transit time, loss & damage, and frequency influence negatively the likelihood of selection of any transport alternative (air or sea). In contrast, the influence of attribute freight insurance on mode choice was observed positive. Moreover, in willingness to pay estimates, across the mode type, exporters were found willing to pay relatively higher amount for reduction in loss & damage while moderate WTP for reduction in transit time and increase in flight frequency.

In addition to the export supply, import demand of Pakistan's mango along with its competitors in the EU market was also estimated. Among the extra-EU exporters, compared to other countries, a high demand of Peru's mango in the EU market was observed. Expenditure elasticities also confirmed Peru's this growing dominance. Moreover, own-price elasticities of Pakistan, Peru, and Cote d'Ivoire showed that a decrease in their own-prices will cause an increase in their quantity demand by EU. However, own-price elasticities for Brazil and Israel were found inelastic. It was also noted that Brazil and Peru exhibit a complementary relationship in their trade.

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8.1.3 Comparative view on findings

A cross-sectional view on key findings of the study is presented here. Review of existing literature and international trade trend reveals Pakistan is exporting merely 7% of its total mango production. Hence, in comparison to its competitors, Pakistan is underperforming in the utilization of its export potential. In the last decade, Pakistan mango export has gradually decreased not only in terms of quantity but by value too. Moreover, the current export pattern indicates that a high percentage of Pakistan's mango is exported to its neighboring markets i.e., Gulf States, which are low value markets. One of the main reasons for high exports to low value markets is less strict import regulations regarding mango quality as compared to the high value markets.

In technical efficiency analysis, it was observed that Diversified-EU export strategy is followed by majority of the Pakistani exporters while in contrast; export margin analysis revealed that adopting Specialized-EU export strategy leads to more profit. Moreover, in comparison with the existing practices utilized by exporters, the key findings in the analysis of factors influencing the firms' export efficiency were observed regarding some determinants i.e., exporter type, exporter category, GAP certification, procurement timing, and pack house facility. For instance, primary data revealed that majority of the exporters are operating as sole and independent exporters whereas the efficiency analysis inferred that other categories of exporters i.e., grower-cum and group exporters, are operating more efficiently.

Similarly, majority of the exporters don't have GAP certification whereas findings suggest that using this certification can result in higher efficiency. Also, the utilization of rented-in pack house was found as a significant contributor to export efficiency whereas majority of the exporters tend to have their own pack house facility. Lastly, the findings on exporters' preference of hired treatment plant facility, application of hot water treatment, and local packing were found in line with their current practices.

Although only 44% of the sample firms are involved in Specialized−EU exports, the profitability analysis revealed that export to this market results in highest net margin compared to other markets. Interestingly, the results of technical efficiency and export margin confirmed that most efficient and profitable exporters are operating in this market which recommends that adopting Specialized-EU export marketing can be more beneficial for the exporters.

Results of discrete choice experiment were found in accordance with the literature. Although reasonable transport costs are associated with sea mode, yet most of the exporters showed concerns for switching from air to sea export mode, due to the high risk of loss & damage issue and increased transit time in sea shipments. However, if loss & damage is mitigated to a considerable extent in sea-freighting, exporters may explore this mode in future. Based on this finding, it can be concluded that exporters are more inclined towards air-freighting. Notably, exporter's highest willingness to pay for reduction in loss & damage among other transport attributes also confirms its importance in affecting the exporters' choice of transport mode.

Import demand analysis revealed that among major exporters in EU market, Peru predominantly leads in terms of quantity and value, while Brazil and Cote d'Ivoire accounts for lower export than Peru. Whereas, in the assessment of export competitiveness, it was noticed that Pakistan has competitive advantage over Israel only while it lacks behind the rest of the countries i.e., Peru, Brazil and Cote d'Ivoire. This implies that Pakistani mango exporters need to follow the sanitary and phyto-sanitary protocols strictly in order to gain the competitive edge over other exporters in EU market. Moreover, both the extra-EU and intra-EU mango trade confirmed that Netherlands consistently holds the dominant position in importing and re-exporting mangoes in the EU market, whereas Spain is gradually increasing its share in re-exporting mango within the European Union.

8.1.4 Study contributions

The study utilized a theoretical framework of export value chain to highlight areas in Pakistan mango industry that require improvement. Mixed sources of data collection, primary and secondary were used for estimation purpose. This study makes a research contribution by employing two-stage data envelopment analysis, export margin analysis, discrete choice experiment, and almost ideal demand system analysis. The incorporation of mixed methods facilitated data triangulation, enhancing the study's validity.

Research on logistics-centric export value chain in Pakistan's agricultural industry is scarce, with a notable gap in studies covering transport related issues. The main contribution of this study is transport mode choice analysis of Pakistan mango exporters, by utilizing stated preference data. To the knowledge of the author, it provides the first application of discrete choice analysis in the context of Pakistan mango exports to European Union (EU). The empirical findings of this study hold significance for stakeholders involved in the mango industry development. In conclusion, the study suggests that Pakistan's mango industry holds substantial potential to contribute significantly in country's economic development. However, to unlock this potential, it is imperative to adopt market-specific export strategy and address the supply chain especially logistical constraints identified in the study.

8.2 Policy recommendations

To address the challenges being faced by the Pakistan mango export supply chain, several key policy recommendations are proposed. Implementation of modern harvesting and post-harvesting practices is crucial for exporting quality mango. Practices such as utilizing clippers and long stepladders, maintaining a 4 to 6-inch stem during harvesting, desapping the fruit with 0.5% lime, and employing plastic buckets for transporting harvested mangoes to packing locations can significantly reduce mango losses and enhance fruit quality. In addition to this, a critical step is to replace wooden crates with cardboard packing to uphold fruit quality and to minimize fruit losses. The government can actively support this shift by promoting the cardboard manufacturing industry and raising awareness among industry stakeholders about the advantages of adopting cardboard boxes.

Pakistan lacks appropriate technologies such as hot water treatment, vapor heat treatment, and irradiation technology to combat the effects of fruit flies. To address this challenge, there is a pressing need to optimize the use of existing treatment plant facilities and establishment of new plants as well to encourage exporters to effectively leverage new innovations in tackling fruit fly infestation and enhance the fruit quality. Also, emphasis needs to be placed on limited use of chemical inputs, contributing to the organic nature of the produce.

High-profit margin EU exports demand compliance with international food safety standards and specific packaging requirements, including corrugated packages. The challenge lies in the unavailability of corrugated packaging material in Pakistan, leading to increased costs for importation and reluctance among exporters to meet high-quality standards. To address this, regulatory measures need to incentivize exporters to adhere to international standards, and government initiatives should attract investments to boost the packaging industry in Pakistan.

There is also need for government intervention to support shipping facilities. While the government may not control international carrier pricing, it can establish a fair pricing policy for the national carrier to promote mango exports. Infrastructure improvements both at air and sea ports, including the introduction of cold storage facilities, are vital for exporting a perishable product like mango. Furthermore, investments are crucial for improving the road conditions and networking in the interior regions of Sindh and Punjab, to facilitate smoother transportation and distribution of mangoes to desired locations.

Moreover, it is imperative to strengthen research and development facilities at universities and research institutions by allocating sufficient funding. This will facilitate the execution of projects aimed at creating mango varieties that align with the quality standards of export markets. Establishing strong coordination between the industry and academia, focused on research tailored to industry needs, can play a pivotal role in addressing numerous challenges within the mango sector. The effective scientific orchard management and implementation of good grading & packing practices are also necessary.

Clarity in the roles of relevant authorities such as the Customs, TDAP and PHDEC is crucial. Long term targeted marketing and export promotion programs need to be developed, involving collaborations with international retail channels, to enhance the international consumer experience of Pakistani mangoes. Lastly, they should also provide the trainings regarding market-specific necessary certification and regulatory requirements to make the export process more accessible to farmers and exporters, encouraging their participation in the export marketing.

8.3 Limitations and prospect for future research

This study mainly assessed the performance of Pakistan mango industry’s supply side in the context of export value chain by using firms & exporters data. However, it would be interesting if the demand of Pakistani mangoes from individual firms/importers in the EU market is also analyzed. This may involve collecting the primary data from both Pakistani exporters and EU importers, providing an in-depth perspective of the whole mango value chain.

The temporal misalignment of results derived from primary and secondary data used in this study constitutes a noteworthy limitation of this research. The primary data collected in 2014, introduces a time lag when compared to the recent secondary data (till 2022). Consequently, the study hinges on the assumption that the dynamics of Pakistan's mango export value chain have remained consistent over the years. To address this limitation, further research can aim to procure up-to-date recent years primary data to ensure a more accurate and relevant comparison. This will also facilitate a comprehensive analysis of the current state of the mango export value chain in Pakistan, allowing for refined policy recommendations.

An inherent limitation arises from the selective inclusion criteria applied during the data collection process for sample firms. Specifically, only firms exporting mango to the EU were considered, leading to the exclusion of those solely exporting to non-EU countries. The resultant dataset lacks representation from exporters engaged solely in non-EU markets. A potential avenue for future research lies in exploring the dynamics of mango export targeting non-EU countries as well. A comparative analysis between the EU and non-EU markets can offer an extensive understanding of the factors influencing mango exports. This gap in the current study underscores the importance of further investigations to elucidate the nuances of mango export strategies in both EU and non-EU markets.

Additionally, during the field survey, it was observed that sample exporting firms are also engaged in domestic supply of mangoes along with the export activities. It leads to the suggestion, considering both domestic and export aspects of the mango supply chain can offer a more effective approach as it may reveal new insights into how firms' export decisions are influenced by their involvement in the domestic mango supply chain as well.

Furthermore, future research can also be conducted on exploring additional aspects of mango safety requirements, such as GAP certification and HACCP standards. Investigating these factors specifically could serve as tools to enhance the export competitiveness of Pakistani mangoes in high-value markets like Europe. Lastly, export markets are dynamic and factors influencing export efficiency can evolve over time. This study's findings reflect a specific timeframe, investigating the ongoing changes in market conditions and regulatory landscape may also be helpful in understanding their impact on Pakistan mango industry.

ABSTRACT

Mango accounts for the second largest share in Pakistan's fruit exports. Therefore, it is important to investigate its export supply challenges in order to reorient the industry towards being efficient and competitive in the international market. In this study, a firm level evaluation of Pakistan mango industry's export performance for different markets is presented. For a better understanding of the export supply chain, import demand of the mango by the EU market was also analyzed.

In export efficiency evaluation, Data Envelopment Analysis (DEA) shows that exporters are operating most efficiently in Specialized-EU market while exporting least efficiently in the Diversified-EU market. This finding reveals that in approaching to high value markets like EU, adopting specialized export practices can enhance exporters' efficiency instead of following the mixed procedures. Overall, independent exporter, GAP-certification, large number of varieties, treatment type-HWT, procurement timing-early, and outsourcing of treatment plant & pack house facility were identified as the major determinants of export efficiency. Furthermore, the results of the profitability analysis confirm the results of export efficiency, as the Specialized-EU market turns out to be the most profitable market compared to the other two markets. However, to secure high profit margins, major cost factors which need to be optimized are; purchase & production cost, international freight cost, treatment and packing costs.

By employing the choice modeling technique, the study establishes the counterfactual effects of transport mode choice attributes and their willingness to pay. For EU market, freight charges in air transport mode and loss & damage in sea transport mode are found to be the major challenging factors which need to be addressed for enhancing exporters' competitiveness in this high value market. Almost Ideal Demand System (AIDS) and various export indices were used to identify the competitiveness of Pakistan among leading mango exporters in the EU market. It was found that Pakistan has a comparative advantage only over Israel and there is a huge potential for Pakistan to increase mango exports in this market. Optimized freight charges and compliance with sanitary and phyto-sanitary (SPS) requirements can help exporters in enhancing their export competitiveness in European market.

The overall findings of this study has contributed valuable information for decision makers and the mango export industry's stakeholders in designing the appropriate policies to enhance Pakistan mango export efficiency and its competitiveness in the international market.

ZUSAMMENFASSUNG

Mango hat den zweitgrößten Anteil an den Fruchtexporten Pakistans. Deshalb ist es wichtig, die Herausforderungen beim Export zu untersuchen, um der Branche Hinweise für Effizienz und Wettbewerbsfähigkeit auf dem internationalen Markt zu geben. In dieser Studie wird zum Einen die Unternehmensebene der pakistanischen Mangoexporteure untersucht, wobei nach den verschiedenen Märkten wie auf die EU spezialisierte oder diversifizierte Exporteure unterschieden werden. Um ein besseres Verständnis der Exportlieferkette zu ermöglichen, wurde zum Anderen auch die Importnachfrage der EU-Märkte für Mango analysiert.

Bei der Bewertung der Exporteffizienz zeigt die Data Envelopment Analysis (DEA), dass Exporteure am effizientesten im als spezialisierte-(EU-Markt) Exorteure agieren, während sie als diversifizierte-Exporteure am wenigsten effizient agieren. Diese Erkenntnis zeigt, dass bei der Erschließung von Hochpreismärkten wie der EU die Übernahme spezialisierter Exportpraktiken die Effizienz der Exporteure steigern kann, anstatt gemischte Verfahren zu befolgen. Insgesamt wurden die Unabhängigkeit der Exporteure, eine GAP-Zertifizierung, eine große Anzahl von Sorten, die Behandlungs mit Heißwasser, ein früher Beschaffungszeitpunkt und die Auslagerung von Behandlungsanlagen und Verpackungseinrichtungen als die wichtigsten Determinanten der Exporteffizienz identifiziert. Darüber hinaus bestätigen die Ergebnisse der Rentabilitätsanalyse die Ergebnisse der Exporteffizienz, da sich der spezialisierte EU-Markt als der rentabelste Markt im Vergleich zu den beiden anderen Märkten herausstellt. Um jedoch hohe Gewinnmargen zu sichern, müssen die Hauptkostenfaktoren optimiert werden, nämlich Einkaufs- und Produktionskosten, internationale Frachtkosten sowie Behandlungs und Verpackungskosten.

Durch die Anwendung der Choice-Modeling-Technik untersucht die Studie die kontrafaktischen Effekte von Attributen der Transportmoduswahl und deren Zahlungsbereitschaft. Für den EU-Markt wurden Frachtkosten im Luftverkehr und Verluste und Schäden im Seeverkehr als die wichtigsten Herausforderungen identifiziert, die angegangen werden müssen, um die Wettbewerbsfähigkeit der Exporteure auf diesem Hochpreismarkt zu steigern. Das Almost Ideal Demand System (AIDS) und verschiedene Exportindizes wurden verwendet, um die Wettbewerbsfähigkeit Pakistans unter den führenden Mangoexporteuren im EU-Markt zu identifizieren. Es wurde festgestellt, dass Pakistan nur gegenüber Israel einen komparativen Vorteil hat und ein großes Potenzial besteht, die Mangoexporte in diesem Markt zu steigern. Optimierte Frachtkosten und die Erfüllung von sanitären und phytosanitären (SPS) Anforderungen können den Exporteuren helfen, ihre Exportwettbewerbsfähigkeit auf dem europäischen Markt zu stärken.

Die Ergebnisse dieser Studie haben wertvolle Informationen für Entscheidungsträger und Stakeholder des Mangoexportsektors geliefert, um geeignete Maßnahmen zur Steigerung der Exporteffizienz und Wettbewerbsfähigkeit der pakistanischen Mango auf dem internationalen Markt abzuleiten.

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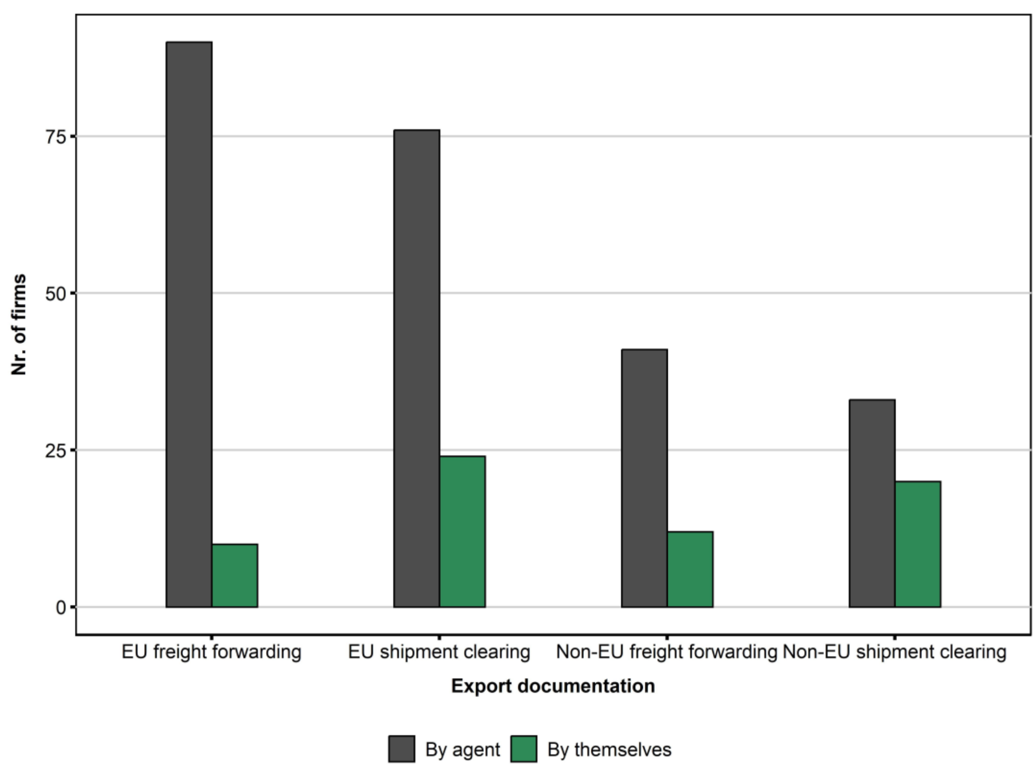
APPENDICES

Appendix 1: World's top ten mango exporting and importing countries (2021)

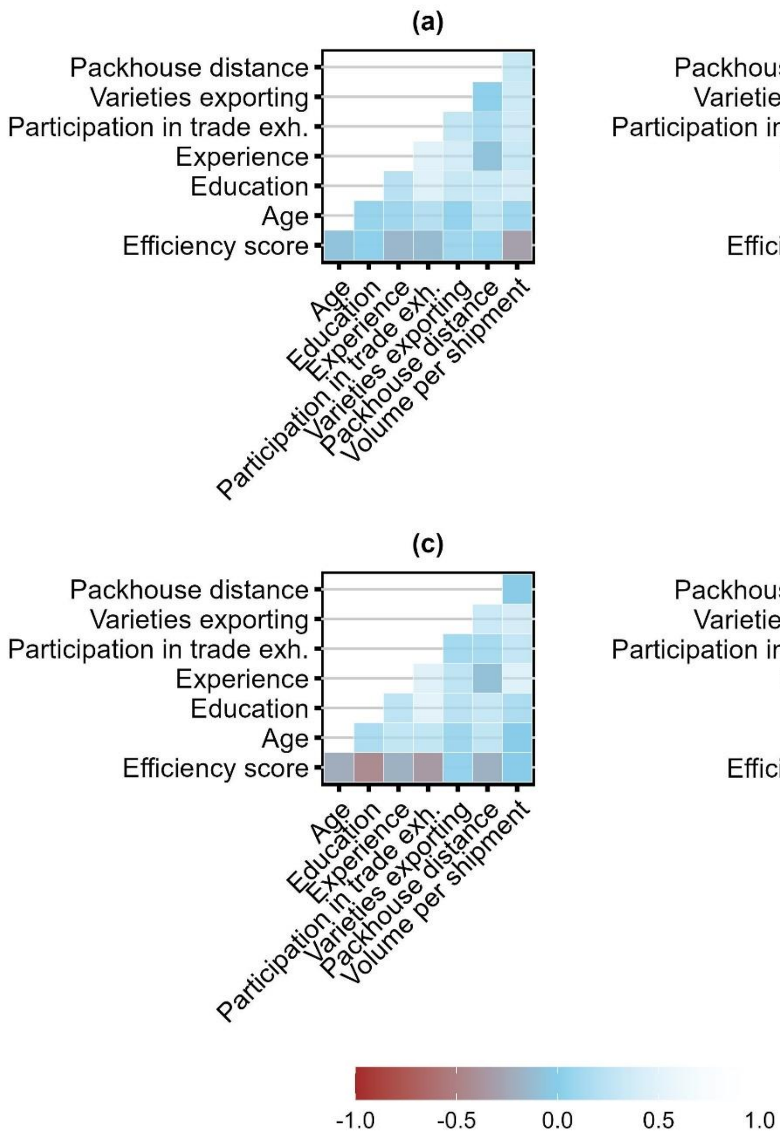
Exporting countries	Export quantity (ton)	Importing countries	Import quantity (ton)
Mexico	429,391	United States of America	558,198
Thailand	382,093	Netherlands	297,256
Brazil	273,071	Germany	110,099
Netherlands	265,935	United Arab Emirates	104,818
Peru	253,042	Saudi Arabia	86,586
Pakistan	189,690	United Kingdom	84,552
India	170,212	Spain	78,823
Vietnam	96,000	Malaysia	76,839
Spain	66,535	Iran	67,921
Ecuador	62,681	France	66,165
World	2,597,573	World	2,203,770

Source: Food and Agriculture Statistics (FAOSTAT), 2023.



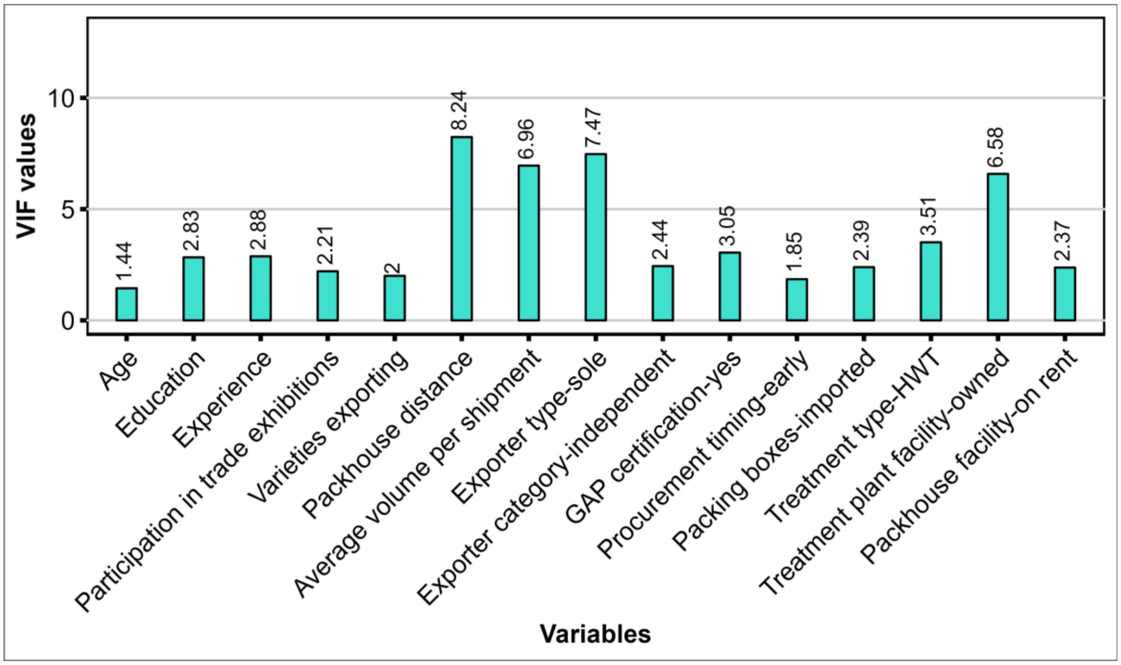
Appendix 2: Export documentation for EU and non-EU markets

Source: Author's illustration based on survey data (2014)



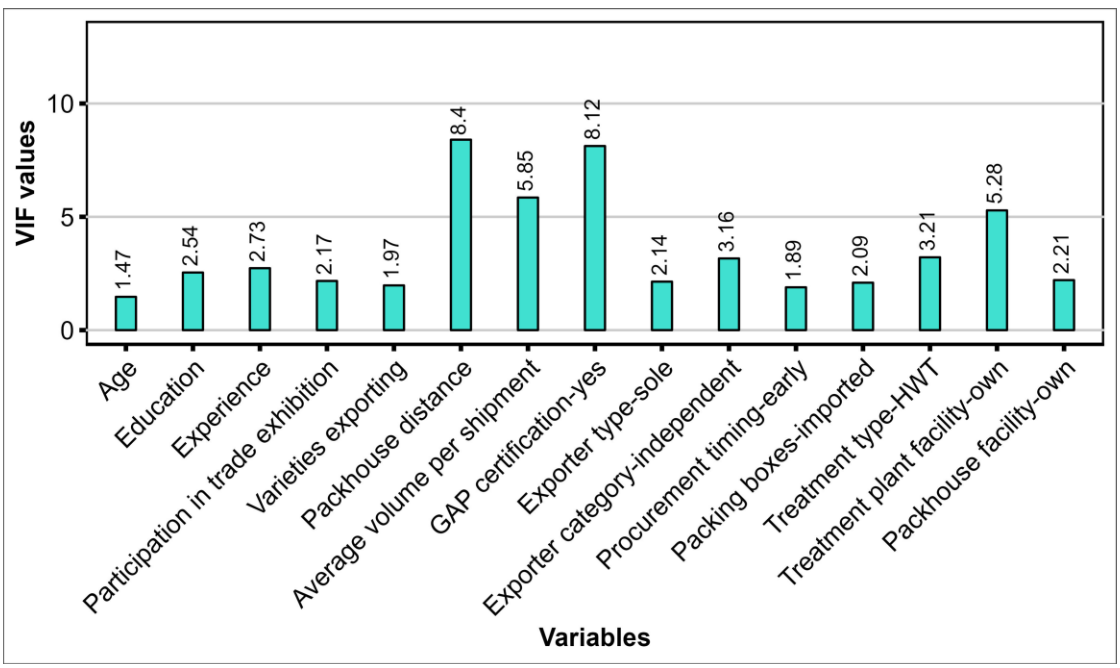
Appendix 3: Correlation plots for different export markets; (a) Aggregate (b) Specialized-EU (c) Diversified-EU (d) Diversified-non-EU

Source: Author's illustration based on survey data (2014)



Appendix 4: Variance inflation factor values of determinants of Specialized–EU exports (tobit regression)

Source: Author's illustration based on survey data (2014)



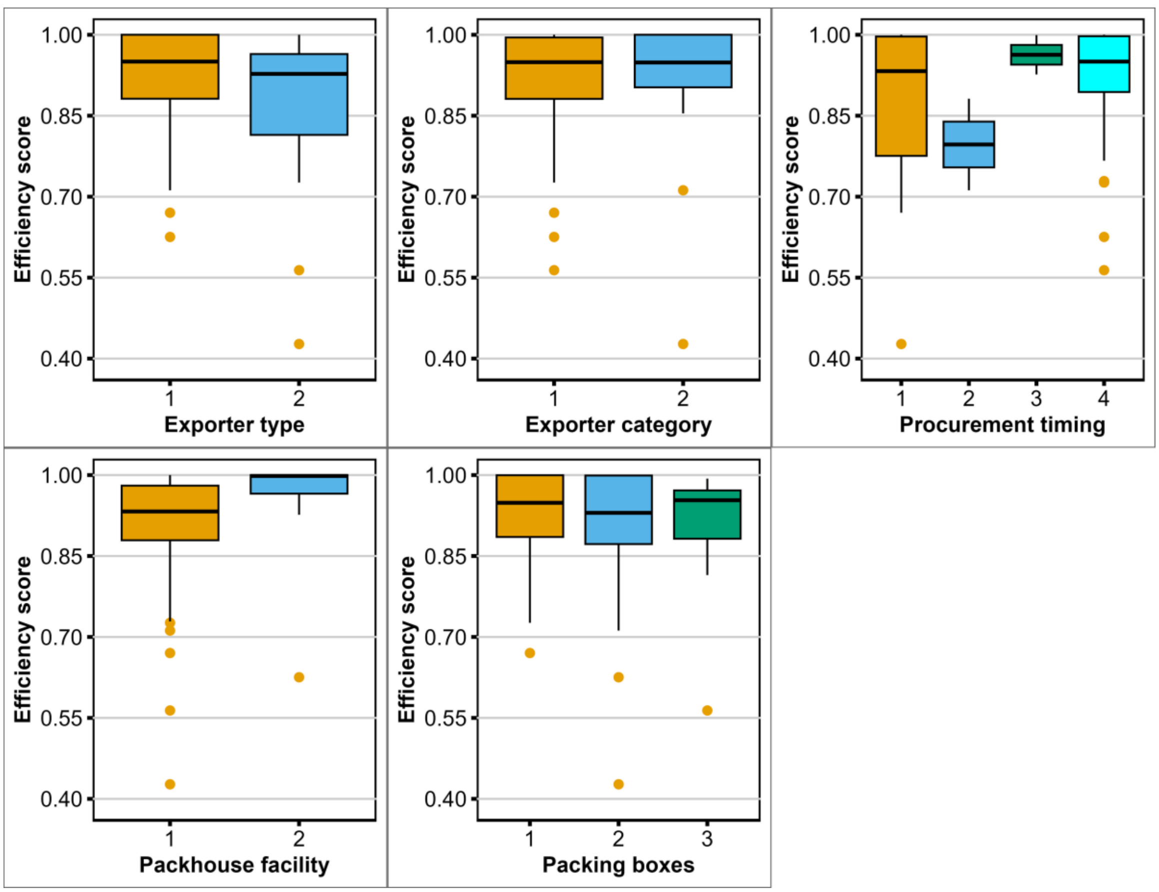
Appendix 5: Variance inflation factor values of determinants of Specialized–EU exports (truncated regression)

Source: Author's illustration based on survey data (2014)

Appendix 6: Distribution of efficiency scores for Diversified–non-EU exports

Efficiency level	Frequency	Percentage
<0.40	0.00	0.00
0.40-0.50	1.00	1.79
0.50-0.60	1.00	1.79
0.60-0.70	2.00	3.57
0.70-0.80	4.00	7.14
0.80-0.90	9.00	16.07
0.90-1.00	39.0	69.64
Nr. of obs.		56.00
Minimum		0.43
Maximum		1.00
Mean		0.90
St. deviation		0.12

Source: Author's calculation



Appendix 7: Distribution of efficiency scores for categorical variables in Diversified–non-EU exports

Source: Author's illustration based on survey data (2014)

Appendix 8: Factors associated with technical efficiency of firms in Diversified–non-EU exports (tobit regression)

Variables	Estimate	Std. error	z value	Pr. (>|z|)
Intercept	0.226	0.154	1.464	0.14
Age (year)	0.001	0.002	0.616	0.53
Education (year)	-0.009	0.007	-1.340	0.18
Varieties exporting (nr./year)	-0.009	0.016	-0.574	0.56
Packhouse to dep. port distance (km)	-0.094	0.026	-3.567	0.00***
Average volume per shipment (ton)	0.134	0.032	4.227	0.00***
Exporter type-sole	-0.177	0.081	-2.200	0.02**
Exporter category-independent	-0.082	0.054	-1.508	0.13
Procurement timing-early	0.033	0.103	0.323	0.74
Procurement timing-mixed	0.181	0.085	2.143	0.03**
Packing boxes-local	0.173	0.053	3.296	0.00***
Packing boxes-mixed	-0.032	0.072	-0.447	0.65
Packhouse facility-own	-0.131	0.060	-2.168	0.03**
Log (scale)	-1.985	0.110	-17.830	0.00***

Note: *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively.
Source: Author's estimations

Appendix 9: Factors associated with technical efficiency of firms in Diversified–non-EU exports (truncated regression)

Variable	Estimate	Std. error	t-value	Pr. (>|t|)
Intercept	0.960	0.093	12.062	0.00***
Age (year)	0.0004	0.001	0.393	0.69
Education (year)	-0.002	0.004	-0.544	0.58
Varieties exporting (nr./year)	-0.003	0.010	-0.285	0.77
Packhouse to dep. port distance (km)	-0.064	0.016	-4.053	0.00***
Average volume per shipment (ton)	0.088	0.019	4.594	0.00***
Exporter type-sole	-0.123	0.049	-2.506	0.01**
Exporter category-independent	-0.045	0.033	-1.389	0.16
Procurement timing-early	-0.025	0.062	-0.405	0.68
Procurement timing-mixed	0.085	0.052	1.642	0.10*
Packing boxes-local	0.106	0.032	3.330	0.00***
Packing boxes-mixed	-0.013	0.045	-0.281	0.77
Packhouse facility-own	-0.087	0.036	-2.397	0.01**
Sigma	0.088	0.008	10.583	0.00***

Note: *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively.
Source: Author's estimations

Appendix 10: Export margin of firms in Diversified–non-EU exports

Activity	Average cost (Rs/kg)	Average cost (USD/kg)
Purchase & production cost	32.33	0.32
Domestic transport cost	4.65	0.04
Storage cost per day	0.49	0.004
Packing cost	17.57	0.17
Clearing agent cost	0.79	0.07
Freight forwarder cost	2.21	0.02
International freight cost	102.14	1.02
Loss & damage cost	1.04	0.01
Labor cost	14.48	0.14
Other charges	0.64	0.006
Final export cost	176.36	1.76
Sale price	332.00	3.32
Gross export margin	156.00	1.56
Tax paid	5.00	0.05
Net export margin	151.00	1.51

Exchange rate: 1 USD = 100 Rs (2014)
Source: Author's calculations

Appendix 11: Weights of determinants of total mango export in Diversified–non-EU market

Determinants	Ridge coefficients	Determinants	Ridge coefficients
Intercept	4.93	Procurement timing-late	-0.09
Age (year)	0.00	Procurement timing-mixed	0.03
Education-secondary	0.01	GAP certification-no	-0.07
Education-higher	0.08	GAP certification-mixed	0.05
Experience (year)	0.00	Exporter type-grower-cum exporter	0.08
Source of initial supply-farmer	0.04	Exporter category-group exporter	-0.08
Source of initial supply-contractor	-0.09	Packhouse facility-rent	-0.09
Source of initial supply-wholesaler	-0.08	Packhouse registration-no	-0.09
Source of initial supply-mixed	0.04	Shipments-moderate	0.35
Procurement timing-mid	-0.10	Shipments-high	0.38

Source: Author's estimations

Appendix 12: Determinants of total mango export in Diversified–non-EU market

Variables	Estimate	Std. error	t value	Pr.(>|t|)
Intercept	4.50	0.67	6.66	0.00***
Shipments-high	2.46	1.00	2.45	0.02**
Experience (year)	0.006	0.01	0.45	0.65
Storage cost (Rs/kg/day)	-0.20	0.13	-1.54	0.13
International freight cost (Rs/kg)	-0.00	0.00	-1.15	0.25
Labor cost (Rs/kg)	-0.05	0.00	-5.79	0.00***
Education-secondary	1.82	0.43	4.18	0.00***
Education-higher	1.65	0.52	3.15	0.00***
Source of initial supply-mixed	0.57	0.32	1.75	0.08**
Freight forwarder cost (Rs/kg)	-0.18	0.11	-1.69	0.09*
Domestic transport cost (Rs/kg)	0.14	0.07	2.01	0.05*
Clearing agent cost (Rs/kg)	0.27	0.28	0.96	0.33
Source of initial supply-wholesaler	0.48	0.49	0.98	0.32

Note: *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively.
Source: Author's estimations

Appendix 13: Export indices of the extra-EU countries (2008-2020)

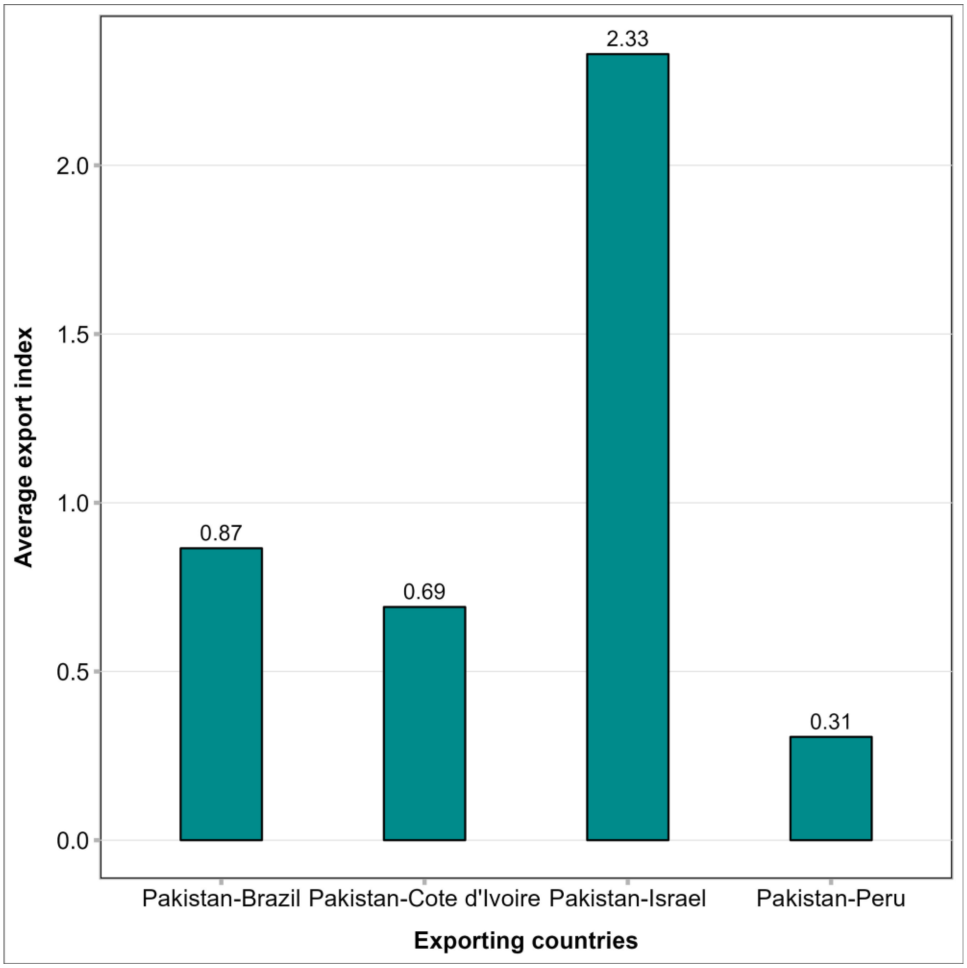
	Years	2008	2009	2010	2011	2013
Brazil	RCA	51.5	52.2	53.4	44.4	48.8
	lnRCA	3.9	3.9	3.9	3.7	3.8
	RSCA	0.9	0.9	0.9	0.9	0.9
Peru	RCA	143.1	119.4	127.7	120.9	168.3
	lnRCA	4.9	4.8	4.9	4.7	5.1
	RSCA	0.9	0.9	0.9	0.9	0.9
Israel	RCA	29.0	22.9	17.4	21.1	15.5
	lnRCA	3.4	3.1	2.9	3.1	2.7
	RSCA	0.9	0.9	0.9	0.9	0.8
Cote d'Ivoire	RCA	75.5	61.0	52.6	59.5	70.4
	lnRCA	4.3	4.1	3.9	4.1	4.2
	RSCA	0.9	0.9	0.9	0.9	0.9
Pakistan	RCA	85.6	82.6	60.9	62.8	56.5
	lnRCA	4.5	4.4	4.1	4.1	4.0
	RSCA	0.9	0.9	0.9	0.9	0.9

Source: Author's calculations based on WITS database (2008-2020)

Appendix 13 (Continued):

	Years	2014	2015	2016	2017	2018	2019	2020	Average
Brazil	RCA	57.6	57.4	53.9	56.5	51.7	60.4	63.5	53.7
	lnRCA	4.0	4.0	3.9	4.0	3.9	4.1	4.1	3.9
	RSCA	0.9	0.9	1.0	0.9	1.0	0.9	0.9	0.9
Peru	RCA	165.3	187.2	199.2	200.1	229.6	223.7	347.8	180.9
	lnRCA	5.1	5.2	5.2	5.3	5.4	5.4	5.9	5.1
	RSCA	0.9	0.9	1.0	0.9	0.9	0.9	0.9	0.9
Israel	RCA	17.6	14.5	18.1	17.6	14.6	14.7	14.9	18.2
	lnRCA	2.8	2.5	2.8	2.9	2.6	2.7	2.7	2.8
	RSCA	0.8	0.8	0.9	0.8	0.8	0.9	0.9	0.8
Cote d'Ivoire	RCA	82.2	52.2	68.2	60.5	68.9	58.4	59.9	64.6
	lnRCA	4.4	3.9	4.2	4.1	4.2	4.1	4.1	4.2
	RSCA	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Pakistan	RCA	19.0	23.1	27.5	20.9	28.1	27.7	8.8	44.4
	lnRCA	2.9	3.1	3.3	3.0	3.4	3.3	2.2	3.6
	RSCA	0.9	0.9	0.9	0.9	0.9	0.9	0.8	0.9

Source: Author's calculations based on WITS database (2008-2020)



Appendix 14: Comparative export performance index (CEP)

Source: Author’s illustration based on WITS database (2008-2020)

Appendix 15: Primary data survey questionnaire

Survey information

Province		Questionnaire nr.	
District		Date of interview	
Tehsil		Name of enumerator	
Phone number		Signature	

1. Respondent's information

Particular	Unit	Response
Name		
Gender	1. Male 2. Female	
Age	Year	
Education*	Year	
Position in exporting firm	1. Owner 2. Manager	

Note: * 1= Can read and write but no formal education, 2= Primary (1-5 years), 3= Middle (8 years), 4= Matriculation (10 years), 5= Graduation (14 years), 6= Master or above (16 years or above).

2. General information about exporting firm

Activity	Unit	Response
Name of exporting firm		
Type of exporter	1. Sole exporter 2. Grower cum exporter	1. 2.
If grower cum exporter	1. Total farm size (acre) 2. Mango orchard area (acre) 3. Other farm area (acre) 4. Avg. mango production (ton/acre)	1. 2. 3. 4.
Type of export items	1. Mango (ton) 2. Others (ton)	1. 2.
Total purchase or production	1. Purchase: mango + others (ton) 2. Production: mango + others (ton)	1. 2.
Local market supply	1. Yes: mango + others (ton) 2. No	1. 2.
Total export	1. Mango (ton) 2. Others (ton)	1. 2.
Participation in trade exhibitions	1. In Pakistan (nr./year) 2. Foreign (nr./year)	1. 2.
Orchard is GAP certified	1. Yes 2. No If yes, certification fee (Rs./season)	1. 2.

Exporting firm registered	1. Yes 2. No	1. 2.
Export license renewal fee	Rs./year	
Taxes paying to govt.	% of export value	
Subsidies getting from govt.	% rebate in tax	
Nr. of employees	1. Permanent 2. Seasonal	1. 2.
Average employees' salary	1. Management (Rs./month) 2. General worker (Rs./month)	1. 2.
Avg. monthly expenditure	Lac/month	
Approximate value of firm's working capital	Million Rs.	

3. Information about mango export

Activity	Unit	Response
Experience	1. Grower a) Production (year) b) Export (year) 2. Sole exporter (year)	1. a) b) 2.
Type of exporter	1. Independent 2. Group exporter	1. 2.
Export destination country	1. EU: country/experience (year) 2. Non-EU: country/experience (year)	1. 2.
Export volume by country	1. EU: (country/ton) 2. Non-EU: (country/ton)	1. 2.
Export variety	1. EU: (country/ton/variety) 2. Non-EU: (country/ton/variety)	1. 2.
Type of importer	1. EU: a) Own outlet b) Pakistani shop c) Others d) a+b e) a+c f) b+c 2. Non-EU: a) Own outlet b) Pakistani shop c) Others d) a+b e) a+c f) b+c	1. 2.
Source of purchase/supply	1. Own production, 2. Farmer, 3. Contractor, 4. Wholesaler, 5. 1+2, 6. 1+3, 7. 1+4, 8. 2+3, 9. 2+4, 10. 3+4	
Bought from GAP certified orchard	1. Yes 2. No 3. Mixed	1. 2. 3.

Type of purchase	1. Whole orchard 2. Ton 3. 1+2	1. 2. 3.
Fruit purchase	1. With treatment 2. Without treatment	1. 2.
Time of purchase* (variety specific)	1. Early 2. Mid 3. Late 4. 1+2 5. 1+3 6. 2+3 7. 1+2+3	

Note:* 1= April-May, 2= June-July, 3= August-September

4. Cost along orchard and local market to exporting firm

Activity	Unit	Response
Production price (variety specific)	Rs./kg	
Purchase price (variety specific)	Rs./kg	
Domestic transportation cost payment	1. Paid separate 2. Included in the purchase price	1. 2.
Mean of domestic transportation	1. Own vehicle 2. Hired vehicle 3. Arranged by the supplier	1. 2. 3.
Domestic transportation cost	1. Sindh a) Orchard to firm (Rs./kg) b) Wholesaler to firm (Rs./kg) 2. Punjab a) Orchard to firm (Rs./kg) b) Wholesaler to firm (Rs./kg)	1. a) b) 2. a) b)
Loading & unloading charges (orchard/wholesale market to packhouse)	1. Own labor 2. Loaded by supplier's labor & unloaded by own labor 3. Daily wage labor (Rs./day)	1. 2. 3.
Performing treatment process	1. EU: a) Yes b) No 2. Non-EU: a) Yes b) No	1. a) b) 2. a) b)
If yes, then treatment type*?	1. EU: a) HWT b) VHT c) HWD 2. Non-EU: a) HWT b) VHT c) HWD	1. a) b) c) 2. a) b) c)
Treatment plant facility	1. Own 2. Hired	1. 2.
Treatment charges	Rs./kg	
Cooling practice	1. Fresh air 2. Cold storage If 2, then charges (Rs./kg/day)	1. 2.
Grading practice	1. By hand 2. By machine	1. 2.
Grading cost	1. Own labor 2. Daily wage labor (Rs./day)	1. 2.
Packing boxes using	1. Local 2. Imported 3. Mix	1. 2. 3.

Packing boxes size using **	1. One kg 2. Two kg 3. Three kg 4. Four kg 5. Five kg	1. 2. 3. 4. 5.
Packing cost	1. Rs./ kg 2. Rs./2 kg 3. Rs./3 kg 4. Rs./4 kg 5. Rs./5 kg	1. 2. 3. 4. 5.
Packhouse facility	1. Own 2. On rent If 2, then rate of rent (Rs./month)	1. 2.
Packhouse registered	1. Yes 2. No	1. 2.
Packhouse storage capacity	Ton/day	
Packhouse storage cost	Rs./kg/day	
Loss and damage	1. Orchard/wholesale market to processing plant (% of qty. purchased) 2. During processing (% of qty. processed) 3. During cold storage (% of qty. stored)	1. 2. 3.

Note: * HWT = Hot water treatment, VHT = Vapor hot treatment, HWD = Hot water dip.
** Packing size is given in net weight of the mango (excluding box weight).

5. Cost along exporting firm to destination country

Activity	Unit	Response
Transport mode using	1. EU: a) Air b) Sea c) Both 2. Non-EU: a) Air b) Sea c) Both	1. 2.
Export qty./country/transport mode	1. Ton/ / 2. Ton/ / 3. Ton/ / 4. Ton/ /	1. 2. 3. 4.
Shipment per country	1. Nr./ 2. Nr./ 3. Nr./ 4. Nr./	1. 2. 3. 4.
Average volume/shipment	1. EU: a) Air (ton) b) Sea (ton) 2. Non-EU: a) Air (ton) b) Sea (ton)	1. a) b) 2. a) b)
Transport mode use experience	1. EU: a) Air (year) b) Sea (year) 2. Non-EU: a) Air (year) b) Sea (year)	1. a) b) 2. a) b)
Airline & shipping line using	1. EU: a) Air b) Sea 2. Non-EU: a) Air b) Sea	1. a) b) 2. a) b)
Local airport and seaport using	1. EU: a) KRA airport b) LHR airport c) KRA seaport d) a+b e) a+c f) b+c 2. Non-EU: a) KRA airport b) LHR airport c) KRA seaport d) a+b e) a+c f) b+c	1. 2.

Transportation charges (firm to domestic air/seaport)	1. Own vehicle (Rs./shipment) 2. Hired vehicle (Rs./shipment)	1. 2.
Loading & unloading charges (firm to air/seaport)	1. Own labor 2. Daily wage labor (Rs./day)	1. 2.
Loss & damage (firm to domestic air/seaport)	1. EU (% of shipped qty.) a) Air b) Sea 2. Non-EU (% of shipped qty.) a) Air b) Sea	1. a) b) 2. a) b)
International freight charges (EU)	1. Airline: from ___ to ___ (Rs./kg) 2. Sealine: from ___ to ___ (Rs./kg)	1. 2.
International freight charges (Non-EU)	1. Airline: from ___ to ___ (Rs./kg) 2. Sealine: from ___ to ___ (Rs./kg)	1. 2.
Loss & damage (origin port to destination port)	1. EU (% of shipped qty.) a) Air b) Sea 2. Non-EU (% of shipped qty.) a) Air b) Sea	1. a) b) 2. a) b)
Clearing agent fee*	1. EU (Rs./shipment) a) Air b) Sea 2. Non-EU (Rs./shipment) a) Air b) Sea	1. a) b) 2. a) b)
Freight forwarder fee for airline	1. EU (Rs./shipment) 2. Non-EU (Rs./shipment)	1. 2.
Freight forwarder fee for sealine**	1. EU (Rs./shipment) a) 20 feet CA container b) 40 feet CA container c) 40 feet reefer container 2. Non-EU (Rs./shipment) a) 20 feet open top container b) 40 feet open top container c) 20 feet reefer container	1. a) b) c) 2. a) b) c)
Treatment verification charges	1. Control union (Rs./person/day) 2. SGS (Rs./person/day)	1. 2.
Bank charges	Rs./shipment	
Other charges		

Note: * & ** clearing agent fee and freight forwarder fee covers every kind of domestic port charges handling, custom documentation etc.

6. Information regarding international freight transport service

Factor	Unit	Response
Time required to prepare a shipment	1. EU (nr. of days) a) Air with treatment b) Sea with treatment 2. Non-EU (nr. of days) a) Air with treatment b) Air without treatment c) Sea with treatment d) Sea without treatment	1. a) b) 2. a) b) c) d)
Transit time (EU)	1. Air (hrs/country) 2. Sea (days/country)	1. 2.
Transit time (Non-EU)	1. Air (hrs/country) 2. Sea (days/country)	1. 2.
Frequency of service	1. EU a) air (nr. of departure/week) b) sea (nr. of departure/week) c) sea (nr. of departure/fortnight) 2. Non-EU a) Air (nr. of departure/week) b) Sea (nr. of departure/week) c) Sea (nr. of departure/fortnight)	1. a) b) c) 2. a) b) c)
Delay in plane/ship departure	1. EU a) Air-once/week (hrs) b) Air-once/fortnight (hrs) c) Air-once/month (hrs) d) Sea-once/fortnight (hrs) e) Sea-once/month (hrs) 2. Non-EU a) Air-once/week (hrs) b) Air-once/fortnight (hrs) c) Air-once/month (hrs) d) Sea-once/fortnight (hrs) e) Sea-once/month (hrs)	1. a) b) c) d) e) 2. a) b) c) a) b)
Offloading at domestic port	1. EU a) Air-once/week b) Air-once/fortnight c) Air-once/month d) Sea-once/fortnight	1. a) b) c) d)

	e) Sea-once/month 2. Non-EU a) Air-once/week b) Air-once/fortnight c) Air-once/month d) Sea-once/fortnight e) Sea-once/month	e) 2. a) b) c) d) e)
Freight capacity	1. EU a) Air enough b) Air not enough c) Sea enough d) Sea not enough 2. Non-EU a) Air enough b) Air not enough c) Sea enough d) Sea not enough	1. EU a) b) c) d) 2. Non-EU a) b) c) d)
Reliability to service	1. EU a) Air (yes/no) b) Sea (yes/no) 2. Non-EU a) Air (yes/no) b) Sea (yes/no)	1. EU a) b) 2. Non-EU a) b)
Consolidation	1. EU a) Air (mango only) b) Air (with other F&V) c) Sea (mango only) d) Sea (with other F&V) 2. Non- EU a) Air (mango only) b) Air (with other F&V) c) Sea (mango only) d) Sea (with other F&V)	1. a) b) c) d) 2. a) b) c) d)
Firm distance from the departure port	1. Airport (km) 2. Seaport (km)	1. 2.

7. Information about European mango market

Factor	Unit	Response
Export price (country specific)	1. EU (per kg) a) By air b) By sea 2. Non-EU (per kg) a) By air b) By sea	1. a) b) 2. a) b)
Shelf life	1. EU (days) a) By air b) By sea 2. Non-EU (days) a) By air b) By sea	1. a) b) 2. a) b)

Market information	1. Pak.'s major competitors in EU 2. Import tax for air shipment 3. Import tax for sea shipment	1. 2. 3.

8. Exporter's perception about export constraints

A) Transport service

Attribute	Air		Sea	
	EU	Non-EU	EU	Non-EU
International freight charges				
Transit time				
Loss and damage				
Freight capacity				
Frequency of service				
Offloading				
Special commercial flights/maritime service				
Freight insurance				
Track and trace				

Rank: 1= Very low, 2= Low, 3= Medium, 4= High, 5= Very high.

B) General constraints

Attribute	Level
Treatment cost	
Cold storage cost	
Grading cost	
Packing cost	
Treatment verification fee	
Low product demand	
EU market price	
Negligence of departments a) Plant protection b) Custom department c) Antinarcotics force	a) b) c)

Rank: 1= Very low, 2= Low, 3= Medium, 4= High, 5= Very high

C) General information about transport mode

1. Do you reserve your cargo space through freight forwarder or by yourself? a) Through freight forwarder b) By myself
2. Are you in contract with airline or shipping line regarding cargo space? a) Yes b) No
3. Which characteristics you consider most important in transport mode selection? a) Freight charges b) Transit time c) Frequency of service

4. Which type of flight you use for mango export? a) Passenger flight b) Commercial flight
5. Are commercial flights available for your target destinations? a) Yes and using b) Yes but not using c) No and don't need d) No but I need If available but not using, why ___________________________ If no but need, why ___________________________
6. Number of commercial flights currently available a) /week b) /fortnight Number of commercial flights required a) /week b) /fortnight
7. What are your comments about Pakistan International Airline (PIA) service?
8. Are you currently using sea transport or not. Will you use it in future? a) Using b) Not using c) Will use it in future d) Will not use in future
9. Which type of container are you using or would like to use for sea freighting? Using: a) Reefer container b) CA container Would like to use: a) Reefer container b) CA container
10. What are the advantages and disadvantages of sea transport over air transport? Advantages: Disadvantages:
11. Is freight insurance available for your loss and damage in export? a) Yes b) No
12. Would you like to have freight insurance or not? Air: a) Yes b) No Sea: a) Yes b) No
13. Currently available freight capacity is enough for your export quantity or not? Air: a) Yes b) No Sea: a) Yes b) No
14. Can sea freighting enhance export competitiveness in EU market? If yes, how?
15. What sea shipping companies need to do to be your regular mode of transportation?
16. Are importers concerned with the mode selection, which mode they prefer & why?

Key Informant Interview

Name of respondent: ________________________________
Responsibility: ________________________________
Age: ________________________________
Education: ________________________________
Date of interview: ________________________________
Place of interview: ________________________________
Contact nr.: ________________________________
Email: ________________________________

1. Which countries are the major competitors of Pakistani mango in EU market and what problems are Pakistani mango exporters facing to compete with them?
2. How transport problem is affecting Pakistan's mango export competitiveness in EU market?
3. Do you think sea freighting can be a regular transport mode for EU in the long run?
4. Which transport facilities you seek from government or shipping companies?
5. What will be the impact on Pakistan's mango export if current transport problems are minimized?

Note: 1 USD = 100 Rupees (2014)
Source: Author's designing

Appendix 16: Set of all choice cards used to collect data

Choice card 1

Attributes	Air (Status quo)	Air (Alternative)	Sea (Status quo)	Sea (Alternative)
Transport cost *(Rupees/kg)*	170	130	30	40
Transit time *(air-hours and sea-days)*	12	8	28	30
Loss & damage *(% of shipped quantity)*	5	2	25	20
Frequency *(nr. of departures/week)*	70	35	1	3
Insurance *(% of loss & damage value)*	0	15	0	30
My choice:				

Choice card 2

Attributes	Air (Status quo)	Air (Alternative)	Sea (Status quo)	Sea (Alternative)
Transport cost *(Rupees/kg)*	170	150	30	50
Transit time *(air-hours and sea-days)*	12	20	28	26
Loss & damage *(% of shipped quantity)*	5	11	25	15
Frequency *(nr. of departures/week)*	70	105	1	4
Insurance *(% of loss & damage value)*	0	50	0	15
My choice:				

Choice card 3

Attributes	Air (Status quo)	Air (Alternative)	Sea (Status quo)	Sea (Alternative)
Transport cost *(Rupees/kg)*	170	150	30	50
Transit time *(air-hours and sea-days)*	12	8	28	30
Loss & damage *(% of shipped quantity)*	5	8	25	30
Frequency *(nr. of departures/week)*	70	140	1	2
Insurance *(% of loss & damage value)*	0	50	0	15
My choice:				

Choice card 4

Attributes	Air (Status quo)	Air (Alternative)	Sea (Status quo)	Sea (Alternative)
Transport cost *(Rupees/kg)*	170	190	30	20
Transit time *(air-hours and sea-days)*	12	20	28	26
Loss & damage *(% of shipped quantity)*	5	2	25	20
Frequency *(nr. of departures/week)*	70	35	1	3
Insurance *(% of loss & damage value)*	0	30	0	50
My choice:				

Choice card 5

Attributes	Air (Status quo)	Air (Alternative)	Sea (Status quo)	Sea (Alternative)
Transport cost *(Rupees/kg)*	170	130	30	40
Transit time *(air-hours and sea-days)*	12	16	28	32
Loss & damage *(% of shipped quantity)*	5	11	25	15
Frequency *(nr. of departures/week)*	70	105	1	4
Insurance *(% of loss & damage value)*	0	15	0	30
My choice:				

Choice card 6

Attributes	Air (Status quo)	Air (Alternative)	Sea (Status quo)	Sea (Alternative)
Transport cost *(Rupees/kg)*	170	190	30	20
Transit time *(air-hours and sea-days)*	12	16	28	32
Loss & damage *(% of shipped quantity)*	5	11	25	15
Frequency *(nr. of departures/week)*	70	35	1	3
Insurance *(% of loss & damage value)*	0	15	0	30
My choice:				

Choice card 7

Attributes	Air (Status quo)	Air (Alternative)	Sea (Status quo)	Sea (Alternative)
Transport cost *(Rupees/kg)*	170	130	30	40
Transit time *(air-hours and sea-days)*	12	8	28	30
Loss & damage *(% of shipped quantity)*	5	8	25	30
Frequency *(nr. of departures/week)*	70	105	1	4
Insurance *(% of loss & damage value)*	0	50	0	15
My choice:				

Choice card 8

Attributes	Air (Status quo)	Air (Alternative)	Sea (Status quo)	Sea (Alternative)
Transport cost *(Rupees/kg)*	170	150	30	50
Transit time *(air-hours and sea-days)*	12	16	28	32
Loss & damage *(% of shipped quantity)*	5	8	25	30
Frequency *(nr. of departures/week)*	70	105	1	4
Insurance *(% of loss & damage value)*	0	30	0	50
My choice:				

Choice card 9

Attributes	Air (Status quo)	Air (Alternative)	Sea (Status quo)	Sea (Alternative)
Transport cost *(Rupees/kg)*	170	190	30	20
Transit time *(air-hours and sea-days)*	12	8	28	30
Loss & damage *(% of shipped quantity)*	5	2	25	20
Frequency *(nr. of departures/week)*	70	140	1	2
Insurance *(% of loss & damage value)*	0	15	0	30
My choice:				

Choice card 10

Attributes	Air (Status quo)	Air (Alternative)	Sea (Status quo)	Sea (Alternative)
Transport cost *(Rupees/kg)*	170	190	30	20
Transit time *(air-hours and sea-days)*	12	16	28	32
Loss & damage *(% of shipped quantity)*	5	8	25	30
Frequency *(nr. of departures/week)*	70	140	1	2
Insurance *(% of loss & damage value)*	0	30	0	50
My choice:				

Choice card 11

Attributes	Air (Status quo)	Air (Alternative)	Sea (Status quo)	Sea (Alternative)
Transport cost *(Rupees/kg)*	170	130	30	40
Transit time *(air-hours and sea-days)*	12	20	28	26
Loss & damage *(% of shipped quantity)*	5	8	25	30
Frequency *(nr. of departures/week)*	70	140	1	2
Insurance *(% of loss & damage value)*	0	15	0	30
My choice:				

Choice card 12

Attributes	Air (Status quo)	Air (Alternative)	Sea (Status quo)	Sea (Alternative)
Transport cost *(Rupees/kg)*	170	150	30	50
Transit time *(air-hours and sea-days)*	12	20	28	26
Loss & damage *(% of shipped quantity)*	5	2	25	20
Frequency *(nr. of departures/week)*	70	140	1	2
Insurance *(% of loss & damage value)*	0	30	0	50
My choice:				

Choice card 13

Attributes	Air (Status quo)	Air (Alternative)	Sea (Status quo)	Sea (Alternative)
Transport cost *(Rupees/kg)*	170	130	30	40
Transit time *(air-hours and sea-days)*	12	20	28	26
Loss & damage *(% of shipped quantity)*	5	11	25	15
Frequency *(nr. of departures/week)*	70	35	1	3
Insurance *(% of loss & damage value)*	0	50	0	15
My choice:				

Choice card 14

Attributes	Air (Status quo)	Air (Alternative)	Sea (Status quo)	Sea (Alternative)
Transport cost *(Rupees/kg)*	170	130	30	40
Transit time *(air-hours and sea-days)*	12	16	28	32
Loss & damage *(% of shipped quantity)*	5	2	25	20
Frequency *(nr. of departures/week)*	70	140	1	2
Insurance *(% of loss & damage value)*	0	50	0	15
My choice:				

Choice card 15

Attributes	Air (Status quo)	Air (Alternative)	Sea (Status quo)	Sea (Alternative)
Transport cost *(Rupees/kg)*	170	150	30	50
Transit time *(air-hours and sea-days)*	12	8	28	30
Loss & damage *(% of shipped quantity)*	5	11	25	15
Frequency *(nr. of departures/week)*	70	35	1	3
Insurance *(% of loss & damage value)*	0	30	0	50
My choice:				

Choice card 16

Attributes	Air (Status quo)	Air (Alternative)	Sea (Status quo)	Sea (Alternative)
Transport cost *(Rupees/kg)*	170	130	30	40
Transit time *(air-hours and sea-days)*	12	20	28	26
Loss & damage *(% of shipped quantity)*	5	2	25	20
Frequency *(nr. of departures/week)*	70	105	1	4
Insurance *(% of loss & damage value)*	0	30	0	50
My choice:				

Choice card 17

Attributes	Air (Status quo)	Air (Alternative)	Sea (Status quo)	Sea (Alternative)
Transport cost *(Rupees/kg)*	170	130	30	40
Transit time *(air-hours and sea-days)*	12	16	28	32
Loss & damage *(% of shipped quantity)*	5	8	25	30
Frequency *(nr. of departures/week)*	70	35	1	3
Insurance *(% of loss & damage value)*	0	30	0	50
My choice:				

Choice card 18

Attributes	Air (Status quo)	Air (Alternative)	Sea (Status quo)	Sea (Alternative)
Transport cost *(Rupees/kg)*	170	190	30	20
Transit time *(air-hours and sea-days)*	12	20	28	26
Loss & damage *(% of shipped quantity)*	5	11	25	15
Frequency *(nr. of departures/week)*	70	140	1	2
Insurance *(% of loss & damage value)*	0	50	0	15
My choice:				

Choice card 19

Attributes	Air (Status quo)	Air (Alternative)	Sea (Status quo)	Sea (Alternative)
Transport cost *(Rupees/kg)*	170	190	30	20
Transit time *(air-hours and sea-days)*	12	8	28	30
Loss & damage *(% of shipped quantity)*	5	11	25	15
Frequency *(nr. of departures/week)*	70	105	1	4
Insurance *(% of loss & damage value)*	0	30	0	50
My choice:				

Choice card 20

Attributes	Air (Status quo)	Air (Alternative)	Sea (Status quo)	Sea (Alternative)
Transport cost *(Rupees/kg)*	170	150	30	50
Transit time *(air-hours and sea-days)*	12	16	28	32
Loss & damage *(% of shipped quantity)*	5	2	25	20
Frequency *(nr. of departures/week)*	70	35	1	3
Insurance *(% of loss & damage value)*	0	50	0	15
My choice:				

Choice card 21

Attributes	Air (Status quo)	Air (Alternative)	Sea (Status quo)	Sea (Alternative)
Transport cost *(Rupees/kg)*	170	190	30	20
Transit time *(air-hours and sea-days)*	12	20	28	26
Loss & damage *(% of shipped quantity)*	5	8	25	30
Frequency *(nr. of departures/week)*	70	105	1	4
Insurance *(% of loss & damage value)*	0	15	0	30
My choice:				

Choice card 22

Attributes	Air (Status quo)	Air (Alternative)	Sea (Status quo)	Sea (Alternative)
Transport cost *(Rupees/kg)*	170	190	30	20
Transit time *(air-hours and sea-days)*	12	16	28	32
Loss & damage *(% of shipped quantity)*	5	2	25	20
Frequency *(nr. of departures/week)*	70	105	1	4
Insurance *(% of loss & damage value)*	0	50	0	15
My choice:				

Choice card 23

Attributes	Air (Status quo)	Air (Alternative)	Sea (Status quo)	Sea (Alternative)
Transport cost *(Rupees/kg)*	170	130	30	40
Transit time *(air-hours and sea-days)*	12	8	28	30
Loss & damage *(% of shipped quantity)*	5	11	25	15
Frequency *(nr. of departures/week)*	70	140	1	2
Insurance *(% of loss & damage value)*	0	30	0	50
My choice:				

Choice card 24

Attributes	Air (Status quo)	Air (Alternative)	Sea (Status quo)	Sea (Alternative)
Transport cost *(Rupees/kg)*	170	150	30	50
Transit time *(air-hours and sea-days)*	12	20	28	26
Loss & damage *(% of shipped quantity)*	5	8	25	30
Frequency *(nr. of departures/week)*	70	35	1	3
Insurance *(% of loss & damage value)*	0	15	0	30
My choice:				

Choice card 25

Attributes	Air (Status quo)	Air (Alternative)	Sea (Status quo)	Sea (Alternative)
Transport cost *(Rupees/kg)*	170	150	30	50
Transit time *(air-hours and sea-days)*	12	16	28	32
Loss & damage *(% of shipped quantity)*	5	11	25	15
Frequency *(nr. of departures/week)*	70	140	1	2
Insurance *(% of loss & damage value)*	0	15	0	30
My choice:				

Choice card 26

Attributes	Air (Status quo)	Air (Alternative)	Sea (Status quo)	Sea (Alternative)
Transport cost *(Rupees/kg)*	170	190	30	20
Transit time *(air-hours and sea-days)*	12	8	28	30
Loss & damage *(% of shipped quantity)*	5	8	25	30
Frequency *(nr. of departures/week)*	70	35	1	3
Insurance *(% of loss & damage value)*	0	50	0	15
My choice:				

Choice card 27

Attributes	Air (Status quo)	Air (Alternative)	Sea (Status quo)	Sea (Alternative)
Transport cost *(Rupees/kg)*	170	150	30	50
Transit time *(air-hours and sea-days)*	12	8	28	30
Loss & damage *(% of shipped quantity)*	5	2	25	20
Frequency *(nr. of departures/week)*	70	105	1	4
Insurance *(% of loss & damage value)*	0	15	0	30
My choice:				

Note: 1 USD = 100 Rupees (2014)
Source: Author's designing